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BOILER FRONTS AND FIXTURES

BY W. H. WAKEMAN.

Many boilers are found in use with their fronts and fixtures so carelessly arranged that it appears as if no plan whatever was adopted when they were set, therefore a few suggestions along this line should be of interest and value, not only to those who are about to purchase and install new boilers, but also to those engineers and superintendents who have opportunities to remodel those already in use.

It is not practical to apply all necessary suggestions to every kind of boiler now used, as it would require too many illustrations and too much descriptive matter, therefore only a pair of tubular boilers will be taken as a standard, as the ideas advanced can easily be applied to other types and combinations of them wherever they admit of it.

Fig. 1 illustrates a battery of two tubular boilers with fixtures arranged to present a neat and symmetrical appearance.

The 2-inch brass feed pipe is carried to the centre of front, where an ell turns it upward. It is followed by a short piece of pipe, on which there is a 1½ x 1½ x 2 inch reducing tee, which forms a branch for each boiler. This tee is described as above because it is customary to give the sizes of pipe for the two opposite ends of tee, then mention the size of branch outlet, consequently the order in which these dimensions are given determines the location of the various pipe connections.

This not only presents a neat appearance, but it secures an equally free passage for water in both cases, therefore so far as this point is concerned there is no reason why one boiler should get more than the other. While writing on this subject, I wish to mention the fact that when one boiler fills with water, and another in the same battery shows a deficiency, it is seldom due to an unequal feed, but is usually caused by a better fire under one of them, thus causing more water to be evaporated, hence it falls in the glass.

A short 1½-inch nipple is screwed into each side of this reducing tee, followed by an ell of the same size, which carries a piece of pipe about 8 inches long, on the upper end of which a valve is screwed. This is used to regulate the amount of feed water delivered to the boiler of which it forms a part, also to entirely shut off the feed water in case that one boiler is laid off for any purpose. Some engineers prefer a gate valve at this point, because it affords a free passage for water. This is the only advantage that can be claimed, and to offset this it requires many turns of the wheel to open and close the passage, and it is more difficult to give only a partial opening when desired to do so, because it is impossible to tell when it really begins to open, except by making experiments for this purpose, or by examining a similar valve that is not connected to pipes, neither of which plans may be practical at short notice.

On the other hand, a globe or an angle valve (or a cross valve, if it can be used) can easily be graduated, because we know that it begins to open as soon as its disc leaves the seat, and either one of them can be quickly repaired by inserting a new disc, or if the seat is damaged it may be made good by the use of an inexpensive valve reseating machine, commonly called a valve file, that should form part of the equipment of almost every steam plant.

There are three practical plans whereby the use of both gate and globe valves at this point may be avoided, as follows: First, a corner valve may be used in place of each 1½-inch ell shown, and both of these may be connected so that pressure will come under the disc when closed, or above it, according to the plan favored by the engineer.

I do not mean that one of these valves can be reversed like a globe valve, as that is not practical, but by taking one and connecting it in place of the right hand ell, pressure will come under the disc, then by putting the same valve on the left hand side, pressure will come on top of it, hence the engineer can have his choice in the matter.

When ordering a pair of valves for this purpose it is advisable to make a sketch of their future location, and send it to the dealer, as otherwise two corner valves that are made exactly alike may be sent and these cannot be used as above described, therefore it is necessary to specify what is wanted. If a sketch is not sent, the order should call for one right hand and one left hand corner valve. In case the local dealer does not carry them in stock, and declines to send for them, order the same of the manufacturer whose advertisement appears on the cover of this paper.

The second plan consists of using angle valves here and

locating their stems in a horizontal position. If this is not desirable, adopt the third plan and place the stems vertically.

Above each feed valve shown in Fig. 1 there is a check valve. As these are in vertical pipes, they may be of the regular vertical type. If these are not desired, the ordinary swing check valves may be used with satisfaction, because the water passes upward through them. This type is not recommended where water flows downward, as they do not prove satisfactory under some conditions.

There is a union above each check valve, which is usually of the ground joint type. As this does not require packing, it is apparently a superior kind of fixture, but when it does begin to leak, it is much more difficult to stop it than to pack an ordinary union, therefore the comparative value of these two types constitutes an open question that the engineer of each plant must decide for himself.

At the highest point in each feed pipe shown, there is an angle valve provided for the purpose of shutting off pressure whenever it is necessary to grind a brass union, pack an iron union, or repair a check valve.

From this point the feed pipe to each boiler passes through the front head to the rear, crosses over and discharges on the other side of tubes, into the body of water already in the shell, thus making it impossible to pump cold water on the shell, which would result in contraction at that point, bringing much more strain to bear than is caused by ordinary steam pressure. It will be noted that in order to secure this arrangement of feed pipe it is necessary to notify the boiler maker that one boiler must have its feed pipe fitted to the right, and the other to the left hand side of head, as they are generally made alike unless otherwise ordered.

A steam gauge is furnished for each boiler, located as shown, but I do not approve of the plan of connecting it to a small pipe which passes through the smoke box and enters the front head just above the water line, because it brings this pipe directly into the hot gases on their way to the stack. Water should always stand in the connecting pipe, but there is little chance for it to stay here under these conditions.

Some engineers connect this pipe into the top connection to water column, but inasmuch as the illustration shows an angle

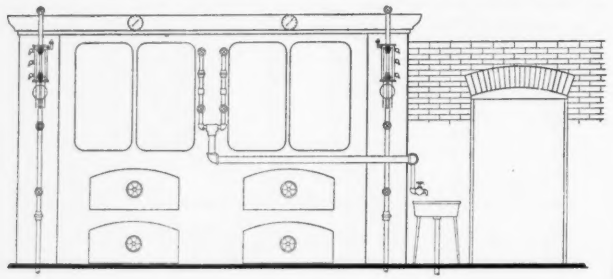

Fig. 1.

valve at this point, it becomes necessary to show a better way.

The main steam pipe of such boilers is from 4 to 6 inches internal diameter, and thick enough to bore through and tap a thread for ¼ or ⅜-inch pipe, affording enough threads to make a secure job. Of course, this must be connected below the main stop valve.

Brass pipe should always be used for this purpose, because it is less liable to become choked by corrosion than iron pipe. Gauges are frequently arranged with a pet cock just below them, so that the pipe may be kept clean by frequently blowing it out. Such a pet cock almost always leaks, making an unsightly spot on the front, therefore it is better to omit it. The small brass pipe above mentioned may be brought through a hole drilled in the cast iron front, about one yard from the gauge, then carried along horizontally until the desired connection is made by means of an ell looking upward. A valve

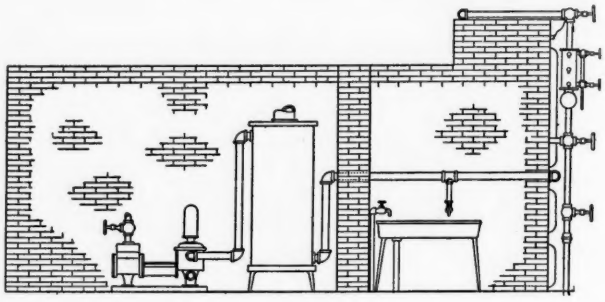

Fig. 2.

is placed near the boiler and a brass union near the gauge. When it is necessary to blow out the pipe, shut this valve, disconnect the union and blow steam through it. Let it stand until cool, then connect the union, open the valve and sufficient water will collect in the pipe to protect the gauge.

The illustration shows one large furnace door for each boiler, which is not favored by some engineers, as it is claimed that too much cold air rushes into the furnace and impinges on the shell every time that the door is opened. If a furnace is fitted with two doors it is possible to open one of them and attend to one-half of the fire, then open the other and attend to the other half, but when the damper is left wide open, air rushes through one door at a very rapid rate, and when both are open the velocity is very much less, therefore the amount of air admitted does not vary directly as the size of opening. It is more trouble for the fireman to open and shut two doors every time the fire needs attention than to use one. A sink is provided near the front of boilers, making it easy to wash whenever necessary.

The brick wall at the right is a feature that should not be overlooked. It is built several feet further back than the boiler fronts, and is furnished with a close-fitting door, thus providing a place for the feed pump and heater where they are not exposed to the dust and dirt usually found in a boiler room. See Fig. 2.

This also illustrates an approved plan for water column connections that is too plainly shown to need any special explanation. The drip pipe is made full size so that when the lower connection is blown out with full pressure of steam on, there is little chance for sediment to remain where it is not wanted.

The angle valve at the top and the cross valve lower down provide a convenient way for the fireman to shut off all pressure from the water column before leaving at night. I have always considered it a good idea to have valves enough about a boiler to enable the engineer or fireman to secure desired results in operating the same. If a new crew does not desire to use them, it is an easy matter to let them alone. I have one battery of two boilers containing 40 valves, all of which are useful.

Both of these illustrations show boilers fitted with flush fronts, which present a better appearance and are better than

the overhanging or half-arch front so frequently used.

I have much respect for those engineers who find themselves in charge of boilers with overhanging fronts, and as it is not practical to have them remodeled, make the best of a bad job, and in some cases even claim that they are the best kind, as it shows a desire to be contented and agreeable.

Of course, it is not difficult to understand why steam users prefer them, as they cost a few dollars less than the better kind.

Boiler insurance companies sometimes recommend them, which is sure to please their patrons who look for cheap work, but I never knew of a case where one of them declined to insure a boiler because it was fitted with a flush front.

Brick masons think they are all right, as only a thin wall can be used around and over the furnace doors, and as this frequently tumbles down, it furnishes them good jobs in building it again.

I have never succeeded in discovering any good reasons why an engineer or a fireman should like this style of front, provided they were perfectly free to choose, although I have considered about all that can be presented on the subject, therefore I conclude that there are none.

A fireman who fires furnaces in connection with overhanging fronts, thus bringing much heat about 18 inches nearer his face than is necessary, sometimes discovers an objection to them, and an engineer who has just examined the grate bars in such a furnace when it contains no fire, then suddenly straightened his back after withdrawing his head from the furnace, has been known to express an opinion freely, while rubbing the storehouse containing his ideas on the subject.

Terms Used In Alternating Current Practice

Definitions of Inductance, Capacity, Impedance, Reactance and Power Factor

While the alternating current generator was one of the earliest forms of generators, yet its commercial application dates back only a few years when compared with the extended use of its direct current brother. It is very probable that had the practical utilization of alternating currents been foreseen, the use of the direct-current generator would to-day be very much restricted, but as the earliest inventors could only see the application of a current which flowed in one direction, naturally they bent their efforts to perfecting this type of machine.

It was not until the transmission of power in large quantities and over long distances came into vogue that the limitations of the direct-current machine and the direct-current method of distribution began to be felt. The transmission of power with direct currents, on account of the limitations of the commutator, necessitated a comparatively low voltage, which demanded lines as large in diameter as one's wrist, while with alternating currents almost any voltage can be transmitted over wires no larger than the finger. This advantage, together with the flexibility of the alternating current voltage, the use of the transformer and other important features, has caused it to become widely used.

In the development of the alternating current, many terms were used which even to this day are an enigma to those who have not had the opportunity of being connected with an alternating-current plant and even to those who do use the various terms connected with the alternating-current industry, their meaning is not clear. The latter fact has been brought to mind by many questions which we have received, asking us to explain some of these terms, and it will be the object of this article to try to explain a few of them.

Unlike the current from the direct-current generator, the alternating current rapidly changes its value and direction at periodic intervals. Such a current reaches a maximum, declines to zero, attains a maximum in the opposite direction and increases again to zero. This variation of the current or of the impressed electro-motive force in its simplest and ideal form follows the law of simple harmonic motion and may be represented by the projection of a point moving in a circle with a constant velocity, as shown in Fig. 1.

In this figure, the point P on the circle is considered as moving with a constant velocity and its projection on the diameter is the value of the pressure at any instant of time. The circle represents a complete revolution, or cycle of change, of the current or the electro-motive force, while the straight line to the right is the development of the circle expressed in degrees, 360 of which constitute one complete period. On this line the instantaneous value of the current or electro-motive force for every position of the point P is plotted and the curve drawn through these points, obtained for the complete revolution, gives a sine curve. In practice, however, the true sine curve is never obtained owing to the irregular magnetic field

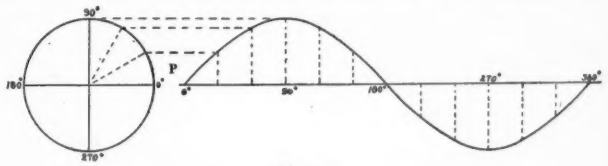

Fig. 1.

but for most commercial purposes, the variation is not so great but that the electro-motive forces may be considered as simple harmonic quantities.

In its general form, the formula for the flow of current in alternating system is similar to that used for determining the flow in a direct-current system. It differs from Ohm's law only in the introduction of certain factors which, however, are sometimes so complicated as to disguise the equation between the current, electro-motive force and the resistance. The value of these factors depends upon the properties of a conductor when under the influence of an alternating current. They are the inductance, capacity and virtual resistance.

When a current flows through a wire, the wire is surrounded with a magnetic field, which, in the case of a direct current of constant potential, has no effect upon the circuit. In the case of an alternating current, the magnetic flux varies periodically

in the same manner as the current and the electro-motive force, which produces a counter electro-motive force or electro-motive force of self induction in the circuit. Since this counter electro-motive force is greatest when the current in the circuit is passing through zero, it is a maximum 90 degrees later than the flux and the current producing the flux.

The effect of this counter electro-motive force is that, when an external electro-motive is applied, the current does not attain its maximum immediately, and when the impressed electro-motive force is withdrawn, the current still flows in the circuit. The effect then of self-induction is to cause the current to always lag behind the electro-motive force in much the same manner as the inertia of fly wheel keeps it moving when the driving power is withdrawn. The strength of the induction is determined by the current and also upon the kind of circuit. One circuit can also be acted upon by an adjacent circuit, causing in the first circuit an electro-motive force of self-induction to be set up. This is called mutual inductance. Inductance can therefore be defined as that quality of a circuit which determines its inductive effect. The unit of measurement is called the henry.

The capacity of a circuit depends upon the quality which it possesses of being able to hold a quantity of electricity. An arrangement of conductors so placed as to have a large capacity is called a condenser. Insulated lines act more or less like condensers. The effect of capacity is opposite to the effect of inductance. It gives a leading current, so that in a circuit where there is capacity, the current may lead the impressed electro-motive force in phase. The unit of measurement of capacity is called a farad.

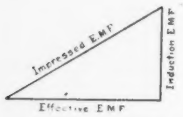

Fig. 2.

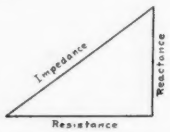

Fig. 3.

Fig. 4.

To drive a certain amount of current through an alternating system of conductors having inductance requires a greater electro-motive force than is needed in a direct-current system to produce the same current. The inductance of a circuit determines the counter electro-motive force, so that it must be overcome by an amount equal to it to produce the required amount of current. Since the effect of inductance always lags 90 degrees behind the current and is greatest when the current is reversing its direction of rotation, the relation of the resultant electro-motive force, impressed electro-motive force and the inductance electro-motive force can be shown by a right angle triangle, shown in Fig. 2.

The horizontal line represents the amount of electro-motive force necessary to drive a current through a circuit without inductance, but if there is an amount of inductance in the circuit represented by the vertical leg of the triangle, the length of the hypothenuse will represent the amount of impressed electro-motive force necessary to produce that same current in the circuit.

The impedance in an alternating-current circuit is the total opposition to the flow of current. It determines the maximum current that can flow with a given impressed electro-motive force. It is made up of two factors: the resistance and reactance. Reactance is the effect of self-induction expressed in Ohms. The relations of resistance, reactance and impedance are shown in Fig. 3, the length of the two legs of the triangle being laid off to their respective values, from which the hypothenuse gives the total value of impedance.

When capacity is in a circuit the current may lead in phase, and since the reactance due to capacity acts in the opposite direction, it is laid down on the diagram in the opposite direction, as shown in Fig. 4, and the impedance in the figure is the resultant of the resistance and the capacity reactance.

When capacity and inductance are both present, the reactance is the difference between the numerical values of the capacity reactance and the inductive reactance. The resultant impedance is then readily found.

The power factor of a circuit is also a term which is very much used in alternating-current practice. It is especially useful in determining the true energy in a circuit when the apparent energy is known and is the ratio of the true watts in the circuit, as measured by a wattmeter, to the apparent watts, which are obtained by multiplying the volts and amperes together in the circuit. The best conditions of a circuit are reached when the ratio comes as near to 100 per cent. as it is possible to get it. If a circuit has a low power factor, it is possible to tax the full capacity of the generators and of the conductors and still transmit very little useful energy.

Care of Dynamos.

The first and most important point to be observed in the care of a dynamo is cleanliness. All machines should be carefully cleaned at least once a day. Special attention should be paid to insulation on the field and commutator and all dust and grit thoroughly removed. In cleaning the machine all connections should be examined and if necessary tightened. After running some time, the commutator should become polished or glazed. No lubrication is necessary unless the brushes cut and then should be applied only at the point of cutting. A very little vaseline applied with a cloth is the best for this purpose. A piece of canvas is the best kind of cloth to use as no threads or fibres are likely to come off and become attached to the commutator and cause trouble with the brushes. If the commutator is rough, it should be smoothed with fine sand-paper. Always raise the brushes before using sand-paper, otherwise they will become filled with grit and scratch the commutator. If the commutator cannot be smoothed with sand-paper, it will be probably necessary to turn down.

In all cases it is dangerous to break the circuit of the field magnets of a dynamo or motor when in operation; not only because by so doing the magneto-motive force of the field is almost entirely removed and thereby the armature becomes practically a short circuit across the mains, but also because of the powerful electro-motive force generated in the field coils by self-induction, when their circuit is interrupted, which may find a discharge through the armature insulation in such a manner as to pierce and injure it. The field magnet connections should always be the first to be completed and the last to be interrupted, when the machine is operated in either capacity.

When run at any other speed than that for which it was designed, the steam turbine becomes very much less efficient than the reciprocating engine. This has been proven by a number of tests made on steamships running at different speeds.

STEAM ENGINE PRACTICE AND DESIGN

Different Methods of Connecting the Piston Rod to the Crosshead and Piston

In the preceding articles, under the heading of "Steam Engine Practice and Design," we have discussed modern types of pistons and crossheads. It will be the function of this article to mention briefly the design of the piston rod which connects the crosshead and piston together.

The piston rod must transmit the steam pressure on the piston to the outside mechanism of the steam engine and it must stand both the pull and the push upon it. It must not bend under compression and it must be strong enough to resist the tensional strains upon it. It must be properly secured to the piston and crosshead and it should be hard enough to withstand the tendency of abrasion and not wear out of round where it passes through the stuffing boxes.

For these reasons, a large number of engine builders now use piston rods made out of high carbon steel which has a high tensile strength and which gives a very hard surface when subjected to cold rolling.

There are five principal methods of fastening the piston to the rod, namely:

1. The piston rod is threaded and the piston screwed on it with a jam nut to prevent unscrewing, as shown in Fig. 1.

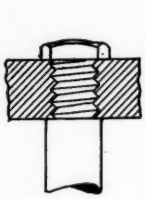

Fig. 1.

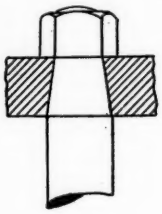

Fig. 2.

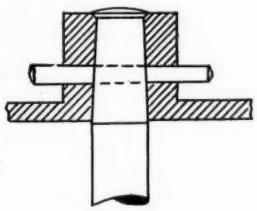

Fig. 3.

2. The piston rod is formed with a tapering surface which ends in a screw thread on which a strong nut is placed, as shown in Fig. 2. The taper surface takes the push and the nut the pull. In each of the above cases, the cylinder head must be so designed that the projecting nut fits into it when the piston is at head centre and care must be taken that the nut does not work loose.

3. The piston rod is tapered and drawn to fit the hub of the piston by a transverse key at right angles to the axis of the rod, as shown in Fig. 3. It is adapted to follower pistons only as the key can be placed within the hollow part of the piston and requires no clearance. The taper of the rod is usually made about 1 in 32.

4. The end of the rod is riveted over. When this method is used the rod is either forced in, as shown in Fig. 4, screwed in or provided with a collar and taper. In any of these cases, the end of the rod is allowed to project through the piston and the projecting end upset as a rivet is headed. It may be done either hot or cold and the head of the rivet often fits a countersink hole in the piston.

5. Another favorite method used by engine builders is the shrunk joint. The hole in the piston is made smaller than the diameter of the rod in the proportion of 1-100ths of an inch for a 4-inch rod. The piston is then heated to low redness which expands the hole in the piston sufficiently to allow the rod to enter it. When it cools, it contracts and forms a very tight joint.

The first method mentioned is not used very often in modern engines. Whenever a piston rod is screwed into the piston it

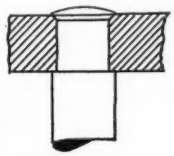

Fig. 4.

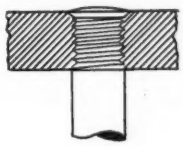

Fig. 5.

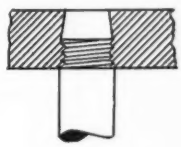

Fig. 6.

is usually riveted over. The Chandler and Taylor high speed engines have the rod screwed in the piston and the end riveted over, as shown in Fig. 5.

The most favorite method of connection with engine builders who use box pistons is to taper the rod and hold it fast with a heavy lock nut, as shown in Fig. 2. The Allis-Chalmers large engines at the St. Louis Exposition were made that way. The American Ball, Ball & Wood, Bates-Corliss in large sizes, Harrisburg and Ideal, each use this method of fastening.

Another usual method of connecting the rod to the piston is to force the rod on by hydraulic pressure and hold it in place with a nut or rivet the end of the piston rod over. Bates-Corliss engines in smaller sizes use the force fit and riveted method; the Bayley engine the same, also the Brown-Corliss and Erie City engines. In the Fulton and Frick engines the rods are pressed on and held in place with a nut, as is also the Harris piston. The Hewes and Phillips builders use the force fit and rivet method. In the Murray Iron Works engines, the force fit with the nut is used, which method is also used in the Phoenix and the Rice and Sargeant engines.

The shrunk joint is used in the Ames piston, as shown in Fig. 6. The rod is first made with a thread and taper fit and then shrunk on. The Minneapolis Steel and Machinery Co. use a bull ring piston, in which the rod is made a taper fit,

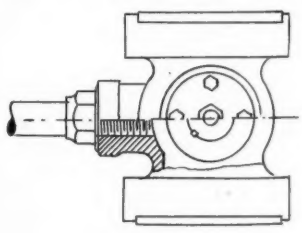

Fig. 7.

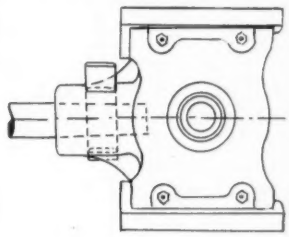

Fig. 8.

the piston shrunk on and the rod riveted and pinned. In the St. Louis Corliss pistons the rod is ground to right dimensions and the piston shrunk on, keyed and riveted.

The transverse key connection of joining the rod to the piston is made use of in the Fishkill-Corliss and a few other types of Corliss engines, as shown in Fig. 3. After the taper

of the rod is driven home by the key, the end of the rod is riveted over.

There are only two methods in general use for connecting the piston rod to the crosshead; the screw and jam nut method and the taper and transverse key method. Of the two, by far the greater number of engines use the former, shown in Fig. 7. Among the engines using the screw and jam nut method may be mentioned the Allis-Chalmers, Ames, American Ball, Bayley, Ball & Wood, Brown-Corliss, Erie City, Fulton, Frick, Harris, Harrisburg, Hewes & Phillips, Ideal, Minneapolis, Murray, Rice and Sargeant and St. Louis Corliss.

The taper and key method, shown in Fig. 8, is used by the Bates, Brown Automatic, Fishkill and Porter-Allen.

Before deciding upon the kind of connection of the rod to the piston and crosshead, the diameter of the rod must be determined. In working out the formula for the strength of a piston rod, it is usually regarded as a beam which is fixed at the piston end and guided at the crosshead end. The rod must be strong enough not to break by crushing or bending. It can easily be calculated that if the length of the piston rod is greater than eight times its diameter, it will break by bending and if the length is less than eight times its diameter it will probably break by crushing.

The diameter of rod is proportional to a constant, depending upon the material out of which it is made, the diameter of the cylinder in inches, the pressure on the piston per square inch and the length of the rod in inches which is usually assumed in preliminary calculations to be the length of the stroke, or

$$d = .013 \sqrt{Dlp}$$

which is a value found to be the mean of those used by different authorities on steam engine design. To find the diameter of the rod in inches, it is therefore necessary to multiply the diameter of the cylinder, D, by the pressure per square inch, p, and the product by the length of the stroke in inches. Extracting the square root of the result will give a value which if multiplied by the constant .013 will give the diameter required.

PRACTICAL HINTS ON THE INDICATOR

By William Kavanagh.

It will probably be admitted by the majority of engineers that the science of steam engineering could never have attained its present position without the aid of the indicator. The practical application of the indicator is, after all, a very simple problem and can readily be understood, but of course we cannot master the details of this instrument unless we do a little studying. We don't need to stay up nights, however, in order to overcome those details because they are sure to follow in regular order. First, we should familiarize ourselves with the mechanism of the indicator; after this we are in a position to learn how to apply it. If we are able to change springs as required for the different pressures and keep the moving parts clean we will have made considerable strides towards its use. Let us suppose that its mechanism and the method of changing the springs are understood, the next difficulty to overcome will be its application. Where a three-way cock is connected to a cylinder it will be only necessary to connect the indicator with the proper spring and after a rigging of some sort has been erected to operate the instrument, we are in a position to take cards.

Where a reducing motion is not available, a lever attached in a line perpendicular to the line of motion of the engine will do; for instance, if the engine is horizontal, the lever may be suspended above the centre of cross head travel, as shown by the line AB, Fig. 1. The lever is free to vibrate at B and a forked end must be made to fit a bolt that is screwed into the cross head, as shown at A. If we slot the lever, as shown at C, we can move the cord up or down the slot so as to obtain the proper travel of paper drum, keeping the string, however, always horizontal. If we place the engine on the inboard centre, the cord from our paper drum to lever should be fairly taut. Now place the engine on the outboard centre; the cord will move the paper drum to its extreme travel. When the cross head is travelling towards the cylinder, the spring located within the paper drum acts and winds up the cord and in this way the cylinder or drum which carries the paper, upon which the card is to be traced, is made to operate.

Cord to operate the drum usually accompanies the instrument but if this cord is not at hand some fishing line can be used to fill all requirements. Two indicator cords should be employed when one indicator is used, as this prevents changing the length of cord every time the indicator is changed from one end of cylinder to the other. Of course, two indicators would be preferable and obviate considerable annoyance; besides, cords could be obtained simultaneously during one revolution. It will be noticed that if we are compelled to change the indicator, considerable time will be lost in making the change and the load on engine may have been increased or lessened, thus changing the point of cut-off. With a three-way cock this trouble is removed to some extent; the objection to the three-way cock is that the connection to cylinder is not close enough, hence the use of two indicators, connected as shown in Fig. 1, which remove this objection. If we wish to know the kind of spring to employ, we can divide the steam pressure by 2 and the quotient will be the required spring. For the sake of illustration, suppose we are carrying 100 pounds pressure, then $100 \div 2 = 50$, so that a 50-pound spring will be required. We should have a spring scale for any spring we employ. This scale is usually made from boxwood or steel and each inch of scale is divided into as many parts as the number of the spring indicates, thus for a 50 spring, each inch of the 50 scale will be divided into 50 equal divisions, and in like manner for any other spring.

We have now arrived at the point where we can take a card. The paper being in position on the paper drum and the engine in motion, we open the indicator cock and permit the piston of the indicator to make at least a dozen strokes; this is done in order to warm the piston and clear the indicator of water

and as soon as the water of condensation ceases, we can press the pencil against the paper and obtain a card. When we press the pencil we should be particular not to impart too much pressure; the rule is to press the pencil as lightly as possible or no heavier than necessary to trace a fine, light line upon the paper; in fact, the lighter the line, the better, the thickness of the line being an index to the experience of the operator. The point of the pencil should be sharp, round and fairly hard. Now we have taken a card and we must exert our knowledge and experience to *read it*. Referring to Fig. 2, the line AB is called the atmospheric line because it is taken before we admit steam to indicator cylinder; of course, the paper drum is in motion during the taking of this line. The line DE is called the back pressure line and the distance between the lines AB and DE shows us the amount of back pressure in pounds measured by the scale of spring. This distance is shown at K and the further apart these lines are, the greater will be the back pressure and the more coal must be consumed to overcome this resistance. The closer the lines the less fuel will be required, all other things being equal. The line DE is called the admission line and in general it should be vertical to the lines AB and DE, which implies that AB and DE should be parallel. The line FH is called the steam line and it should be parallel to AB. The point H is called the point of cut-off, the curve OE indicates exhaust opening. The exhaust remains open until the piston reaches the point I, when the exhaust closes for compression, the curve MN being called the compression curve. The steam port opens at the point N and remains open until the piston reaches the point H, when it closes and expansion begins. The curve HIO is called the expansion curve and its form should coincide closely with a curve called the hyperbola.

In general, this curve will follow the law of the expansion of gases, laid down by Boyle and Marriotte, which reads: "The volume of a gas is inversely proportional to the pressure it supports," or, in other words, the product of pressure and volume is always constant. Let us look at this in another way: Suppose the dotted lines represent the cylinder of an engine and that steam is admitted up to the point H at 100 pounds

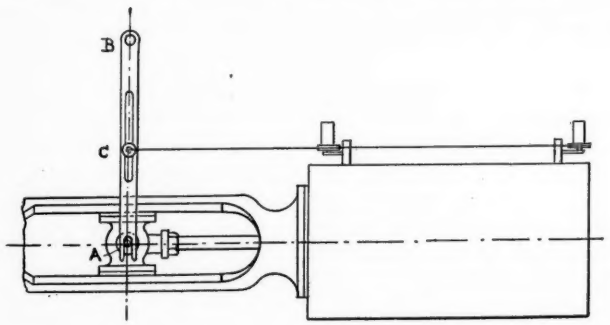

Fig. 1.

pressure, and assume the piston to travel to the point I. Now the volume of cylinder DFRK is twice as great as the volume bounded by the lines HSRK. Here we see that the same quantity of steam must fill or expand to double its original volume, hence the pressure will be halved, therefore if we double the volume we halve the pressure, or if we increase the volume three times, we divide the pressure by 3, and so on, for any number of volumes, also the reverse is true, that is, if we halve the volume we double the pressure and if we decrease the volume by 3, we multiply the pressure by the same figure. According to this rule, the pressure at the point I should be 50 pounds. By laying our scale along a line vertical to the atmospheric line AB and measuring from the line DE to any part of the curve, we will be able to tell the pressure acting upon the engine piston at that point. Since steam loses heat in expanding, it does not follow this curve exactly but it is close enough for all practical purposes. The next step is to figure out the horse power of a card. Take a compass and divide the

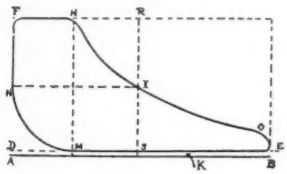

Fig. 2.

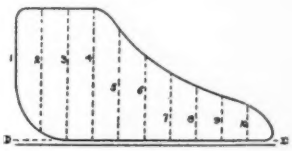

Fig. 3.

line DE, Fig. 3, into 10 equal divisions, the greater the number of divisions the better, but 10 parts will do. Draw the lines 1, 2, 3, 4, etc., all vertical to DE and take the scale of spring and measure line and write down the result. Measure all the other lines, as 2, 3, 4, etc., and add them together. Suppose their sum is equal to 450; then divide 450 by 10 and we will obtain what is called the average pressure. It will be noticed that if the card was divided into twenty equal spaces we would divide their sum by 20, and so on, for any number of divisions. Now 45 pounds is the average pressure. Find the area of the piston head and multiply this area by the average pressure; multiply this product by the number of feet the piston travels in one minute and divide the result by 33,000; this will give the indicated horse power. If accuracy is desired, we should subtract half the area of the piston rod from area of piston head and proceed as above described. It will be noticed that the average pressure is such a quantity that if permitted to act upon the piston throughout the entire stroke it would perform the same amount of work as the varying pressures acting upon the piston. Some engineers prefer no compression, arguing that "energy is lost in compressing the steam" but these men forget that the compressed steam will give back the same energy that was required to compress it. In general, engines using compression run better and more economically, using less oil, less fuel, and cooler bearings, not to mention wear.

Where the Heat Goes.

When a pound of coal is burned under a steam boiler, about 22 per cent. of the heat goes up the chimney, 1 per cent. is lost through the grate and 5 per cent. is lost in radiation. Seventy-two per cent. is then available in the steam going to the engine, of which about 2 per cent. is lost in the steam pipes, 2.5 per cent. lost by radiation from the engine and 58.5 per cent. lost from the engine exhaust, which leaves the engine with about 9 per cent. of the heat for useful work.

There are four limitations to the output of a continuous current generator; namely, insufficient mechanical strength, insufficient voltage at the brushes, excessive sparking and excessive heating.

Swiss and French High-Tension Power Transmission Plants

By Frank C. Perkins.

There are a large number of small streams in the mountains of France and Switzerland which are now being utilized extensively for high-tension power transmission plants supplying current for operating both incandescent and arc lamps as well as electric motors in villages and towns within a reasonable radius of the power house.

It may be interesting to consider the details of two of these hydro-electric power stations of moderate size, in which alternating currents of high tension have been utilized. The accompanying illustrations on front cover and Fig. 1 are interior and exterior views of the Kubel Electric Station in Switzerland. It is equipped with four turbines directly connected to four three-phase alternating current generators. The total capacity of these machines is 1200 kilowatts and the power transmission line is operated at 10,000 volts, supplying current to 27 villages. Though only the water of a comparatively small river is at hand, it has been possible by the use of special construction to obtain the above output. An artificial pond of 53 million cubic feet capacity serves as a reservoir for periods of low water, collecting all superfluous water in the rainy season. The conduit leading to this reservoir is subterranean and is 2.8 miles long.

Eig. 1.—Exterior of the Kubel Electric Power Plant, Switzerland

The electric power transmission at Chevenoz, France, is located about 8.7 miles from Thonon and 13.5 miles from Evian. The general arrangement of the turbines and generators at this station as well as the details of construction of the latter and the switchboard connections of the same may be noted in the accompanying drawings, Figs. 2 and 3. The water is first conducted from the mountain stream through a canal 2600 feet in length and is finally brought to the turbines in the power house through a steel pipe 825 feet in length. The latter has a diameter of 40 inches, the steel pipe being 0.35 inches in thickness. The total fall is 180 feet with a discharge of 56,600 cubic feet per second, giving a total capacity of 1100 horse power.

The switchboard is of marble mounted on an iron framework, and is equipped with the usual switches and measuring instruments connected as shown in diagram Fig. 3. The switchboard transformer reduces the pressure from 3000 volts to 140 volts for the use of the measuring instruments, while a three-phase transformer of 3 kilowatts capacity is provided for

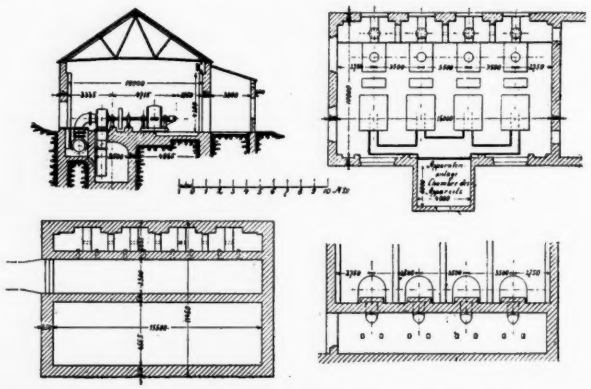

Fig. 2.—Hydro-Electric arrangement at the Chevenoz Power Plant, France.

lighting the power station, the pressure of the lighting circuit being 120 volts.

The high-tension power transmission line from the Chevenoz power house to Evian consists of 3 silicon bronze conductors, each 4 mm. in diameter, while two telephone wires are also provided on the same pole line, which is 8 miles in length, the telephone wires also being of silicon bronze and 2 mm. in

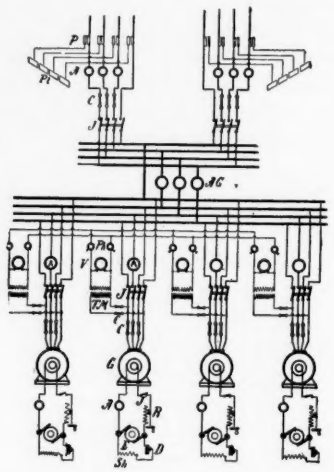

Fig. 3.—Connections of Generators and Switchboard at Chevenoz Power Plant, France. G-generators, E-exciters, Sh-shunt, R-regulator, V-voltmeter, A-ammeter, Ph-phase lamps.

diameter. The poles are from 80 to 125 feet apart and the conductors are mounted on double porcelain insulators. The high-tension power transmission line from the Chevenoz power house to Thonon is 9 miles in length and consists of 3 conductors 5 mm. in diameter. The current is transformed from

3000 volts to 120 volts at various substations, which consist of small towers containing transformers ranging from 14 to 60 kilowatts each.

The power house is 52½ feet long and 33 feet wide, the total height to the travelling crane, which has a capacity of 8 tons, is 14 feet. There are four turbines each having a capacity of 350 horse power, at a speed of 430 revolutions per minute. These turbines were designed and constructed by Piccard, Pictet & Co., of Geneva, Switzerland. The electrical equipment was installed by the Oerlikon Machine Co., of Oerlikon, near Zurich, Switzerland, and includes four induction alternators supplying a three-phase current of 5,200 volts, the pressure being 3000 volts for each phase and the frequency 50 periods per second. These alternators are directly connected to the turbines by insulating couplings of the Cachyn System, the speed of the generators being 430 revolutions per minute. Each half of the armature of this alternator has 42 slots and 21 coils, each of which has 34 turns of copper conductor having a section 3.5 x 4.1 mm. The bore of the armature is 1330 mm. in diameter and the field magnet has a diameter of 1324 mm., leaving an air space of 6 mm. The revolving field magnet or inductor has 2 x 7 poles, and the field coil has 480 turns of copper wire.

CURRENT REGULATION OF ARC DYNAMOS

Methods in General Use for Supplying Constant Current to Arc Lamps

While in many instances the constant potential arc light has replaced the constant current arc lamp, yet for certain purposes, such as for street lighting, the constant current arc lamp is still used extensively. In the latter case, considerable energy is expended at the points of illumination and as these points are usually separated from each other by considerable distances, it is more economical to connect the lamps in series and use a constant current than it would be to run them in parallel. When the series method is used, a single line completes the circuit of all the lamps, as shown in Fig. 1, so that the line can be made of much smaller wire than in the case of a constant potential circuit, because, on a constant current circuit, as the load increases, the power or energy transmitted is increased by raising the voltage, the current remaining unaltered; while in a constant potential circuit an increase of load is met by an increase in current and the wires must be large enough to carry the maximum current.

The size of wire necessary in any circuit is determined by the amount of current it must carry, and not by the voltage or the energy transmitted, so that a wire which is large enough to supply one lamp on a constant current circuit is large enough to supply all the lamps on the circuit.

An ordinary arc lamp, when it is in working order, requires between 45 and 50 volts to force its rated current through it. This current is used principally for heating the carbons to incandescence, across which an arc is maintained. The arc proper does not give out more than 5 per cent. of the light, the light coming principally from the heated end of the positive carbon. The tip of the positive carbon is called the crater and when it is at the point of incandescence, the temperature is about 3500 degrees Centigrade. When burning, the positive carbon becomes hollow on the end, while the negative carbon becomes pointed by the flying carbon particles, but it does not reach such a bright degree of incandescence as the positive carbon. Owing to this fact, the positive carbon burns away about twice as rapidly as the negative carbon.

Arc lamps have what is termed a spherical candle power, and commercial lamps of 800, 1200 or 2000 spherical candle power are in use. The arc lamp of 800 candle power takes a current of 4.5 amperes, that of 1200 candle power 6.6, and that of 2000 candle power 9.8 amperes. The candle powers are rated according to their greatest brilliancy, which is about at an angle of 45 degrees, as shown in Fig. 2. Thus the ordinary street lamp, while rated at 2000 candle power, will only give this amount along an angle of 45 degrees to the centre line of the carbons. At any other angle the brilliancy is much less and the average will be about 800 candle power.

Since the brilliancy of a lamp depends upon the amount of current passing through it, the current of an arc light machine must not exceed or fall below its normal value no matter how the load is varied, for the slightest change affects the quality of the light at the lamps. As the voltage required per light is about 50 volts and as commercial circuits contain from 60 to 120 lamps, the maximum voltage of an arc light circuit will be about 3000 for the 60 lamp circuit and 6000 for the 120 lamp circuit. Under these conditions it may happen that the load is variable, in which case the arc machine must regulate between wide fluctuations of voltage and at the same time maintain a steady current.

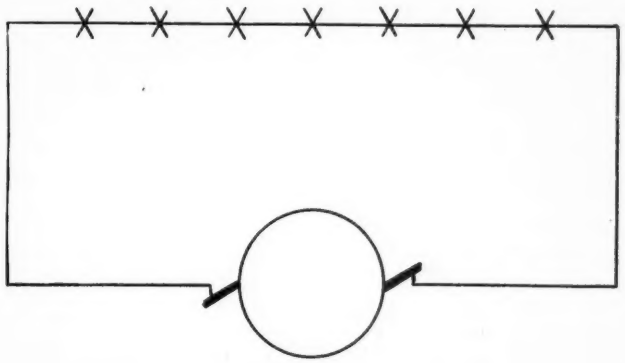

Fig. 1.

To perform this regulation quickly, all constant current machines rely on armature reactions for the regulations, since they vary simultaneously with the current in the circuit. The following conditions are aimed at in all successful constant current generators: There must be a large number of armature turns, since the current is small; the magnetic field of the machine must be distorted; the path of the line of force of the field coils must be long and of small area, so that the magneto-

motive force cannot be readily changed; the path of the lines of force due to armature magnetization must be short and of great area, so that the magneto-motive force of the armature will change with the slightest change of current; and the pole pieces must have a high density of magnetization.

As will be noticed, there are so many conditions that must be met in order that a machine will produce constant current under all loads, that automatic mechanical devices are used to aid the regulation. These automatic devices are not the only regulators, as the casual observer would think, but they are only secondary to the natural self-regulating tendency of the armature; that is, the regulating device acts like a governor on a steam engine and regulates for the gradual and greater changes of the load, while the armature reactions act like the fly wheel and take care of the smaller and more sudden fluctuations.

Of the two general methods used for regulating the current on arc dynamos, one method is to cause the machine to develop an electro-motive force in excess of that required for the load and collect an electro-motive force just sufficient for the load;

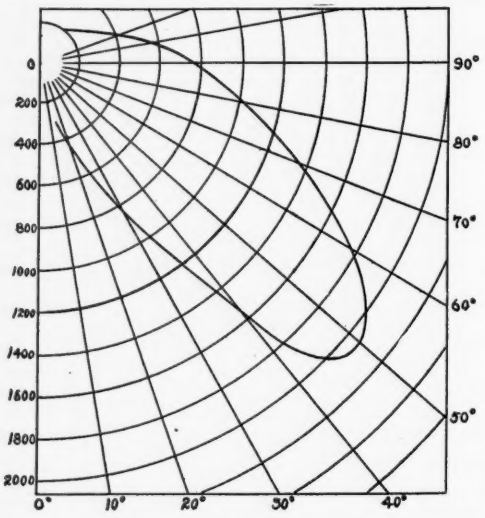

Fig. 2.

and the second method is to vary the magnetizing force in the field magnets just enough to put the required voltage on the line. The first method is performed by shifting the brushes from the neutral plane, which in a closed coil armature causes a counter electro-motive force to be developed in those conductors lying between the neutral and commutating plane, which reduces the voltage the right amount. In an open coil armature, the brushes when in the maximum position connect to the circuit those coils of the armature which at that instant have the maximum electro-motive force generated in them. By shifting the brushes either way coils can be connected to the circuit. These coils have some electro-motive force less than the total electro-motive force generated in them, and the amount of shifting regulates the pressure on the line.

The second method of regulating arc light machines by varying the magnetizing force in the field magnets depends upon the fact that the magnetizing force is dependent upon the ampere turns on the field coils. In practice, this is varied by either cutting out or short circuiting some of the turns, or changing the current in them by means of a variable resistance which is shunted across the field terminals.

The Brush arc machine is regulated by a variable resistance in shunt with the field coils, and as the field current is changed, the position of the brushes is also changed. The Wood arc dynamo has an armature of the closed coil type, requiring a commutator of many segments with but a small potential between any two adjacent ones. The machine operates by generating full pressure at all times and by automatically setting the brushes to take off as much potential as is necessary. The Excelsior arc dynamo has a closed coil armature and is regulated by cutting out sections of the field winding, at the same time the position of the brushes is shifted. The Thompson-Houston dynamo employs an armature on which there are three coils. The outside ends of the coils are connected to a three commutator, from which the current is collected by four copper brushes connected in multiple. Regulation is affected by shifting the brushes.

Whether, however, regulation is effected by changing the position of the brushes or by changing the field excitation, sparking will occur, unless there is some means taken to prevent it, and this is done in a different manner in the different makes of machines.

Suggestions for Starting Up an Ice Plant.

The system will now be ready for charging with ammonia when the air has been thoroughly expelled from the system as described. To charge the machine, the tank of anhydrous ammonia should be connected through a suitable pipe to the charging valve of the compressor. The ammonia tank should be weighed before charging and when connected to the charging valve, the tank should have its closed end about one foot higher than the other end. The machine should be run at slow speed when sucking the ammonia from the tank, with the discharge and suction valves wide open. When one of the ammonia tanks has been completely emptied, which can be told by weighing and comparing the weight with that of the empty tank, it must be removed by first closing the charging valve and another tank connected up. This is repeated until the machine is sufficiently charged to work, when the charging valve should be finally closed and the main expansion valve opened and regulated.

A glass gauge upon the liquid receiver will show when the latter is partially filled, and the pressure gauges and the expansion pipe leading to the refrigerator coils becoming covered with frost, will indicate when a sufficient amount to start working has been inserted. It is sometimes advisable to slightly warm the ammonia tanks in some convenient manner while transferring their contents to the machine, as otherwise if frost forms on the exterior of the tanks they will not be completely discharged.

When the compressor is started and the regulating valve opened, it is important that the temperature of the delivery pipe be noted carefully and if it shows a tendency to heat, then the regulating valve must be opened wider and should the pipe become cold, the valve must be slightly closed. This valve should be so adjusted that the temperature of the delivery pipe is the same as the cooling water leaving the condenser. If, however, the charge of ammonia in the machine is insufficient, the delivery pipe will become heated, even if the regulating valve is wide open. There are many additional signs of the healthy working of the apparatus which can easily become

recognized by those in charge, such as the frost on the ammonia pipes, the action of the pressure and vacuum gauges with each stroke of the piston and the like.

If air finds its way into the system through leaky stuffing boxes, improper regulation of the expansion valve or any other way, its presence in any considerable volume is shown by a kind of whistling noise, the liquid ammonia passing through the expansion valve in an intermittent manner, a rise of pressure in the condenser and other obvious signs. This air must be got rid of through the purging cocks in a similar manner to that which remains in the system when first charging the machine. The presence of any considerable amount of oil or water in the system, which may result from careless distillation, will cause a reduction in efficiency and will be evidenced by shocks within the compressor cylinder. The temperature of the system can be regulated by running the machine at a higher speed or by increasing the back pressure or both. The back pressure can be regulated by means of an expansion valve or valves fitted between the receiver and the refrigerator evaporating coils or pipes in the main liquid pipe.

It is always necessary that a liberal supply of oil for lubricating purposes be forced into the stuffing box of the compressor, otherwise it will be found that the heated ammonia gases at high pressures will very rapidly cut through the packing. Pure mineral is the best to use for this purpose as other oils will saponify when they come into contact with the ammonia and trouble will be encountered.

It is also necessary to know the proper amount of water to use in the jacket of the compressor. This amount will vary with the condensing pressure; about 12 gallons per hour per ton refrigerating effect per day of 24 hours when the condenser pressure is about 90 pounds, while when the condensing pressure is about 150 pounds, the amount of water required will be about 50 gallons or more per hour. In general, the larger the amount of cooling water the better. This latter fact is also true of the amount of water to be used in the condenser, for the lower the temperature of the condensed ammonia, the less will be the pressure against which the compressor will have to work and consequently the greater will be the saving in fuel and in wear and tear on the moving parts. The amount of condensing water required will vary with the temperature of the cooling water and the temperature at which it is run from the condenser. If the condensing water is run into the condenser at a temperature of about 60 degrees and leaves at the overflow or waste at a temperature of 90 degrees, the quantity of water required will be about one gallon per minute for each ton of ice capacity per 24 hours. If, however, the temperature of the waste water is 75 degrees, instead of 90 degrees, with the initial temperature the same, it would require about 2.5 gallons per minute, but a reduction of about 40 pounds in the condensing pressure would be effected.

Owing to the high cost of water in many localities, it is not economical to reduce the temperature of the condensed ammonia below a certain point and when these conditions are met with every effort should be made to utilize the overflow water.

After starting up the plant, the condenser pressure affords a means of ascertaining whether or not the apparatus contains the proper full charge of ammonia, or if the leakage losses are sufficient to render it necessary to insert an additional supply. In this connection it is advisable to keep a record of the temperature of the condensed ammonia when leaving the condenser, and also of the condensing and suction pressures at regular intervals. If the condensing pressure is found to be falling, as compared with a previous period of time, while at the same time the condensing temperature and suction pressure remain constant, it will be evident that the charge of ammonia has been reduced to a sufficient extent to require recharging. The reduction in the condensing pressure is caused by a diminution in the charge of ammonia, which allows the remaining gas to have a larger space wherein to condense. When, according to the records, it is found that the condensing pressure has fallen about 10 pounds, enough ammonia to restore the original condensing pressure should be inserted into the machine.

Before ice can be made, the brine tank must be filled with brine of the required strength. The brine ordinarily used is a solution of either common salt, technically called chloride of sodium, or chloride of calcium in water. The brine must be strong enough so that it will not freeze at the temperature at which it is worked and must not be too strong because its specific heat grows less as brine gets stronger; that is, its capacity of absorbing heat grows less. One advantage that brine composed of chloride of calcium has over chloride of sodium brine is that it can be cooled to a much lower temperature without freezing for a given strength and hence carry off a greater amount of heat.

For testing the density of brine a specially-designed hydrometer is used, called a salinometer. If used as a hydrometer, the Beaumé scale is used, or if it is graduated according to the salinometer the readings are about four times the readings on the Beaumé scale. The brine should be made in a separate tank and should not be used until its strength is determined and the impurities settled to the bottom. When common salt is used, about 3 pounds of dry salt are used per gallon of water and after being thoroughly dissolved the strength should be 23° Beaumé. With this strength the solution will freeze about 1° Fahr. The same proportion holds true with calcium chloride, but owing to difficulty in dissolving the calcium chloride, the solution had better be made stronger than required and its strength reduced afterwards by adding water as required. Calcium chloride brine at 23° Beaumé freezes at 5 degrees below zero Fahr.

If during the operation of the freezing apparatus, the brine in the tanks begins to smell of ammonia, it indicates a considerable leakage. The brine should be periodically tested with some solution, such as Nessler's reagent. This solution is used for discovering traces of ammonia in water or brine. It is made by dissolving 17 grams of mercuric chloride in 300 cubic centimeters of distilled water, to which is added 35 grams of potassium iodide dissolved in 100 cubic centimeters of water; this mixture should be constantly stirred until a slight permanent red precipitate is formed. To this solution should be added 120 grams of potassium hydrate dissolved in about 200 cubic centimeters of water, allowed to cool before mixing. The amount is then made up to 1 litre and mercuric chloride added until a permanent precipitate again forms. After standing for a sufficient time, the clear solution, known as Nessler's reagent, should be placed in glass-stoppered blue bottles and kept in a dark place.

If a few drops of this reagent be added to a sample of the suspected brine or water and the slightest trace of ammonia be present, a yellow coloration of the liquid will take place

and if a large quantity of ammonia be present, it will produce a dark-brown color.

When everything has been found to work satisfactorily in the freezing room, including the thawing apparatus and ice hoist, the ammonia condenser should be examined as it is now under pressure and any leaks will develop. The burning sulphur test will indicate if there are any of these, which, after they are located, should be marked with chalk. The ammonia must then be emptied from the condenser, so that it can be repaired. If, however, the ammonia condenser is found to be in good condition, the plant will be ready for operation for the summer.

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Old Colony Council Asks Some Interesting Questions.

The following questions illustrate what Old Colony Council, No. 14, A. O. S. E., is doing along educational lines. Prizes are given to those who bring in the best answers and they are doing all they can to make things interesting for the engineers in their vicinity. The questions asked at each meeting are as follows:

MEETING FEBRUARY 2, 1905.

What care should we give the firebricks in a boiler setting?

What should be done if a boiler head should crack from one tube to another?

In what class of boilers does the dry sheet have to be protected?

Why does the front head flange outward when sheet projects to form a smoke arch?

Where is the feed-water introduced in some of the different boilers?

If we give the same lead at each end, why is it that all single valve engines will cut-off earlier at the crank than at the head end?

What two things give us compression in an engine?

What would it indicate to see a boiler setting cracked?

MEETING FEBRUARY 16, 1905.

Does a glass indicate a true water level in a boiler?

How would you know if your boiler wanted cleaning out?

How do you keep a safety valve in order?

What is the benefit of a good damper regulator?

Name the different pipe connections on a boiler.

What is the difference between a bag and a blister?

Where are the man-hole and hand-hole plates in some of the different boilers?

Why are they made oval in shape?

MEETING MARCH 2, 1905.

Why do we give more lap to steam valves of large Corliss engines than we do to small ones?

What advantage do we get in having two eccentrics on a Corliss engine?

Should there be two wrist plates?

On a compound engine, what does the receiver gauge show?

How many different ways can a Corliss engine be made to do more work?

If a feed pump is seen to be running at an increased speed without any additional steam, how do you locate where the trouble is?

How would you find out if coil in a heater was leaking?

What are cushion valves on a duplex pump?

MEETING MARCH 16, 1905.

Name the principal fixtures of a hydraulic elevator pump.

Does the main valve have lap on the riding cut-off engine in the examination room?

Where is the greatest pressure exerted on a boiler?

Upon what does the strength of a furnace tube depend?

Why is a round tube stronger than a square one?

How would the strongest tube be constructed?

In staying boilers with flat surfaces is it better to use many stays of small diameter or a few of larger diameter?

What does a universal joint accomplish?

Why should a pulley be balanced?

MEETING APRIL 6, 1905.

What is the running and which is the standing balance of a pulley?

At what speed should a running balance be made?

Which is the strongest side of leather, the smooth or grain side, or the rough or flesh side?

Should a belt tightener be placed on the tight or slack side of a belt?

What is the best location for the collar that prevent end motion of a shaft?

What is a double beat valve?

What is an expansion joint?

What damage might a leaking throttle valve do, and how would you prevent it?

MEETING APRIL 20, 1905.

How can a gauge glass be cleaned internally?

What is meant by absolute pressure of steam?

What precaution would you use with the gauge glass if the feed water is dirty?

How are condenser tubes made tight?

In a horizontal tubular boiler what part is known as the dry sheet?

Why should this be protected from the action of the fire?

Where bolts are secured with lock nuts should the thin or thick nut be put on top?

Why should they be placed thus?

MEETING MAY 4, 1905.

If the upper valve on a water glass is shut in, what effect would this have if the water stood at two gauges before the valve was shut?

If the lower valve is shut or the passage becomes clogged up what effect will it have?

Why should the exhaust pipe on a steam engine be larger than the steam pipe?

What prevents the piston from striking the ends of the cylinder?

How can you tell which way an engine will run, the steam chest cover being on?

How should the steam gauge be connected, and why?

On low pressure heating systems, why should check valves be placed on the return pipes?

If a condenser was attached to a slide valve engine that had been set to run non-condensing, what changes, if any, would be necessary?

MEETING MAY 18, 1905.

What is the difference between a lifting and a non-lifting injector?

What automatic valves are on an independent condenser?

What valves are between a jet-condenser and the air-pump?

What vacuum gives most economical results with surface condensing engines?

What are the advantages and disadvantages of independent air and circulating pumps?

MEETING JUNE 1, 1905.

What class of valves have no lap?

What is an indirect connected engine?

In a vertical engine how do we get more compression on crank or lower end than we do on head end?

Is internal corrosion dangerous?

What harm is caused by admission of engine oil to a boiler?

How does it get into a boiler?

Why are patches of scale more harmful to a boiler than a uniform coating all over the fire-sheets?

What care should be taken in cutting a gasket for a steam chest cover of any single pump?

MEETING JUNE 15, 1905.

Name all the reasons why we raise the water level in a boiler on leaving at night with a banked fire?

How would you handle a blow-off valve?

How do they estimate power and amount of saving of a feed-water heater?

What are cushion valves on a duplex pump?

What does it indicate to see cushion valves on a single pump?

What is the travel of a pump valve?

When is a slide valve travelling at the highest rate of speed?

If a quarter of an inch were turned off an eccentric and the strap babbitted to fit it, how would it affect the travel of the valve?

MEETING SEPTEMBER 7, 1905.

If an eccentric were keyed to a shaft and you wanted to give a little more lead to the valve, how would you do it?

How would you know if an engine had a direct valve or not, by the relative position of crank and eccentric?

How would you equalize the clearance of an engine if it was not already so?

What are the different things that might happen to a steam gauge that would injure it?

If a feed pipe burst inside of the deed valve, what would you do?

Describe how you would cut out a boiler from a battery.

Explain in detail how you would cut it in, and where, if you were carrying 100 pounds pressure on battery.

What is the difference between a Babcock & Wilcox and a Heine boiler?

MEETING SEPTEMBER 21, 1905.

How would you proceed to make a slide valve engine do more work, without raising pressure or speed?

How will this affect the compression?

If you had 100 pounds pressure in a cylinder and cut off steam at one-fourth stroke, what would be the pressure at end of stroke?

What is clearance left for?

Explain all the principles upon which a lubricator works.

How would you find the strain per square inch on a boiler plate through its weakest point where pressure, diameter and thickness of plate were given?

What is the difference between dry and wet returns?

Should wet returns be used?

MEETING OCTOBER 5, 1905.

If a crank broke on the high pressure side of a cross compound engine, how would you run it single?

Which will require the largest receiver, a cross or a tandem compound engine?

In what class of engines is this receiver converted into a reheater?

How much lap should a piston valve have?

Which will have the most exhaust lap, a piston or a slide valve?

What makes compression take place earlier with a light load on a piston valve?

Why does a piston valve that is controlled by a wheel regulator have to steam lap?

What care should a damper regulator have?

MEETING OCTOBER 19, 1905.

What can be done to find out water level in boiler when foaming?

What are the necessary valves in connection to a boiler?

What is the use of a check valve?

How would you find out if it was leaking, with different modes of feeding?

What care should an automatic pump and receiver have?

How would you set the valve of a slide valve engine, eccentric and valve both adrift?

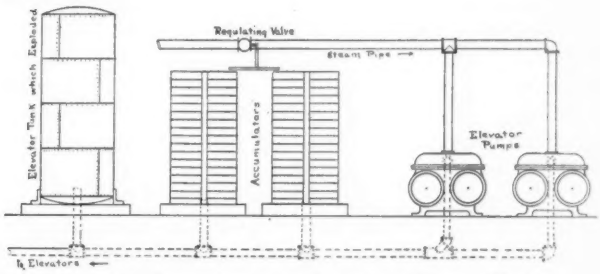
What is a "shim" or "liner" used for?

What is compression for?

Disastrous Explosion of an Elevator Tank.

The bursting of an elevator tank in the power house of the Pennsylvania Railroad, at Broad Street Station, Philadelphia, on Sunday evening, April 30th, caused the death of two engineers who were in the engine room at the time of the explosion and almost caused a panic among the hundreds of passengers who were waiting in the train shed.

The engine room in which the explosion took place is situated underneath the elevated tracks and contains, among other numerous apparatus, two hydraulic pumps, two accumulators and one elevator tank. The elevator pumps, accumulators and tank were used to operate the large hydraulic elevators which were used for lifting freight between the ground floor and the elevated tracks.



Sketch of Connections before Explosion of Elevator Tank

The arrangement of accumulators, tank and pump is shown in the accompanying sketch. The water pressure on the system was regulated by the accumulators, which, when they reached a certain height, operated a lever valve which shut the steam off the pumps. The working pressure of the system varied between 270 and 300 pounds per square inch.

When the tank exploded, there were five engineers in the room, three of whom narrowly escaped injury. The two men killed were George Tollinger, the chief engineer, and his assistant, George Hoy. Hoy was standing near the tank when it

exploded and Tollinger was some distance away. The roar of the explosion was deafening and the force of the released air, together with falling steam pipes and escaping steam rendered assistance to the doomed men impossible for some time. To add to the confusion, the dynamos were put out of service and every light was extinguished. When found, the body of Hoy was horribly cut, but the body of Tollinger was uninjured, he evidently having been killed by the concussion and the inhaling of the steam.

The force of the explosion and the extinguishing of all the lights greatly frightened the crowd of passengers in the station, and when the cry of fire was raised there was a wild stampede for the exits. Wome nand children were trodden under foot and the passengers from the arriving trains added to the tumult. Many signal lights on the block system were out for a time and the outgoing and incoming trains were instantly halted and traffic was thrown into a state of the greatest confusion.

The cause of the explosion was due to overpressure in the elevator tank, which was 5 feet in diameter and 18 feet long. Just what caused the overpressure is unknown, but it was probably due to the sticking of the regulating steam valve which allowed the pumps to pump an overpressure on the system. As the ratio of the areas of the water and steam pistons was 12 to 1, the pumps were capable of pumping a water pressure of 1200 pounds for every 100 pounds steam pressure. The upper part of the elevator tank was filled with compressed air, as is usual with such tanks, and the explosive effects were due to it.

The tank was nearly new and showed no signs of deterioration inside or outside. It was made out of ¾-inch plates in four sections and the longitudinal seams were butted and held together with straps double riveted. The ends were dished and the force of the explosion and the ductility of the metal were most clearly shown by one of these ends, which struck a riveted girder above, and so great was the force with which the end of the tank hit it that the indentations of the rivet heads were as clear as if done with a sledge and die.

The refusal of the regulating valve to perform its work is given as the cause of the explosion, because before the explosion the accumulators would often be driven to the top of their travel and come to a stop with a bang before the pumps would be regulated, and as the explosion occurred at a time when there was very little demand for water pressure, it would not take very long for the pressure to attain the dangerous point if the pumps were not shut off.

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Boiler Plants in Bleaching and Dyeing Mills.

A paper on the above subject was read by Mr. George S. Rockwood before the seventy-eighth meeting of the New England Cotton Manufacturers' Association held in Boston, Mass., on April 27th. In this paper, the author discusses the question which arises in the reorganizing and consolidating of the steam generating and power departments of an old bleaching and dyeing plant which has grown up with the business and which contains a series of old and new buildings which are supplied by several complete boiler and engine plants, besides a water turbine or two. In these plants the shafting runs all sorts of ways and does not lend itself to a central drive, and any concentration of the boiler plant must be considered along with the uses to which steam is to be put and the distances it must travel.

With this sort of plant, Mr. Rockwood goes on to state that steam must be supplied to the bleachery, the dye-house, the print-works, the fast-black plant. The boiler house should be on the edge of the railroad track or, it may be, the wharf. The products of combustion must be discharged at such a point and elevation as to insure freedom from dirt in the bleachery; while, for the same reason, the fast-black plant, though it gets its cloth from the bleachery, should not be near enough to it to discharge fumes in that direction. Without doubt—though contrary to one's first impulse—the chimney should be as close to the bleachery as it is possible to get it. Smoke never, in any state of the atmosphere, settles straight down; whereas, the smoke from a chimney situated one or two hundred yards on one side of the bleachery may quite easily soot the cloth when the breeze blows towards it and the humidity is high.

In the light of the manufacturing requirements touched upon above, an examination of the actual state of things, made by an outsider with a view to suggesting radical improvements, is likely to leave one in an exhausted and discouraged condition of mind. He feels, after seeing the menagerie of unsuitable buildings, shafting, power and boiler plants, that it is time to call in the surgeon and then start again.

As to reorganizing the power, in nine cases out of ten nothing can be done to effect much economy by concentration unless the owners will consider the expense of an electric drive. Fortunately, the power requirements of the kind of mills in question are relatively small. Many times the number of boilers needed to supply a single large engine for driving shafting are used to make steam for kiers, dry-cans, dye-tubs, ageing machines, etc. The machines to be driven are widely scattered. The cost of an electric generator and motors is relatively small; and to establish the policy of concentration made possible by the use of the electric transmission of power is of great importance to the subsequent growth or alteration of the plant as a whole. The steam turbine can only be used to drive a generator. It cannot drive direct, by ropes or belts. The steam turbine cannot be used, therefore, unless the electric drive is also used. But the turbine has an advantage, as a source of dye-house or print-works power, over the reciprocating engine in one important particular; namely, its exhaust steam is pure and uncontaminated with cylinder-oil and can be used in creating a hot-water supply in the place of live steam. The steam turbine and generator combination is very considerably cheaper in cost of installation, and is somewhat so in cost of operation, as compared with the steam engine-and-generator unit. From Mr. Rockwood's experience thus far with steam turbines, he would favor their purchase every time and for every place when the electric transmission of power is in itself desirable. It may be said, in passing, that electric motors should not be put up inside the bleacheries themselves, nor in any place where fumes or vapor can harm them, otherwise they may prove expensive indeed.

Mr. Rockwood then takes up the concentration of the boiler plants, in which he says that just what design of boiler plant constitutes the best possible arrangement is something of a riddle. The key is found in devising a satisfactory coal-handling scheme. The plant which has the most economical coal-handling methods in use will be the most economical producer of steam; so that the answer to all other questions of design should wait until after the designer has fully convinced himself on that point. Here, too, is where the greatest of ex-

pert opinion lies. The question of selection between water tube and fire tube boilers, for instance, and of whether or not to use economizers, and of mechanical versus chimney draft, are of subordinate importance.

On the coal and ash handling subject, Mr. Rockwood says that the true economy is found in adapting as much machinery and as expensive coal pockets—in comparison with the more simple reliance on man and beast power—as will return sixteen per cent. or thereabouts on the capital which pays for them; and it will be found, on investigation, that all the advantages of the modern boiler house may be had with far less expense if the coal pocket be placed directly on the ground and on one side or end of the boiler plant proper. By thus leaving the roof of the boiler house unencumbered with the coal pocket, not only is the simplest and cheapest structural-steel design possible, but a skylight over the centre-isle between the boilers makes the whole boiler room light, airy and fit for a decent man to work in; whereas, some of these modern boiler rooms can only be compared to underground dungeons.

In reference to automatic stokers, the paper states that the desirability of purchasing automatic stokers is a very much discussed subject. Certainly they will not pay if their use is unaccompanied by mechanical means for filling their hoppers. How often does one see in a mill plant any attention paid to this point! We have often seen stokers put in with great expectations of economy of labor and coal; and the fireman is also expected to shovel every pound of coal seven feet up into the hopper from the boiler room floor. How much attention is a fireman likely to spend on the economical working of the machine when coaling it is attended with so much laborious effort? With a mechanical method of coal handling, which is useless without stokers, the mere saving in labor is sufficient to warrant their use; and, if operated as intended and as they may be seen operating in many large plants, stokers will save coal over the best ordinary hand firing, especially when working with bituminous coal.

With regard to the best type of boiler, Mr. Rockwood has no fault to find with the upright fire tube type. A preference for this type is based on its price, $7.50 a horse power erected, its compactness, the ease with which tubes may be swept, and the fact that it gives superheated steam. It is a great steamer, and there is nothing to choose between its economy and that of any other correctly-designed boiler and furnace. It is desirable, however, that only clean, soft water shall be fed to a boiler of this type. If scaly waters are to be used, the B. & W. or Sterling water-tube boilers are to be preferred.

Economizers are frequently omitted from otherwise fire-rate plants. This, however, is unquestionably a mistake, as they take the place of just so much heating surface, if similarly placed in the boilers, and deal with comparatively cool water, which could not be dealt with in a boiler so effectively. It would be better to deliberately install fewer boilers and supplement them with economizers, than to try to do the whole work with boilers. 600° or even 650° Fahrenheit are not too hot for the gases as they issue from the boilers, where economizers are used; yet 400° to 500° are much more common figures. Economizers save about 9 per cent. of the total fuel bill. In a certain plant the economizers cost, completely installed, and making due allowances for the extra cost of the boiler house because of their presence, something less than $15,000. The coal burned per annum is about 15,000 tons, which is $3.00 a ton, equals $45,000. Nine per cent. of $45,000 = $4,050, which is 27 per cent. of their cost, or 11 per cent. more than the 16 per cent. necessary according to the rule given above.

Mechanical draft versus chimney draft is another question not fully settled in the minds of experts. For bleacheries, however, both should be provided. The chimney is needed because the soot must be discharged at a high altitude to avoid contact with white goods. By means of the fan a smaller installation of boilers will do the work of supplying sudden demands of dye-house or bleachery for gusts of steam for an hour or two, than would otherwise be required. This is much the more economical scheme as compared with the large reservoir of hot water idea, embodied in a much larger boiler plant than the fan would make necessary and working the greater part of the day very lazily under a light chimney draft, simply to be there when the heavy demands for steam come. It is not, apparently, generally realized that a stoker grate is more durable under a heavy fire than under a light one; and sudden changes from heavy fires to light ones cause the grate to burn out very fast. Again, a mechanical draft system costing $5,000 installed will do the work of 16 220 horse power boilers with 12; the 16 having only a 175-feet stack. Each boiler, with its full equipment and building, costs about $8,000. The difference between 16 and 12 is 4 boilers saved, or $32,000. Thus there can be no question as to the desirability of providing both chimney and fan in this class of boiler plants; and the same thing has been found true in large electric power plants.

Few owners realize when they commence construction what a large proportion of their cost will go for piping and pipe-covering. It is of the first importance, then, that it be well done from first to last, and by an experienced hand. One advantage resulting from the very flexible suspension of the boilers in the illustration is in the tightness of the headers and flanges in the steam mains. The boilers can follow, to a slight extent, the motions of these mains.

Mr. Rockwood concludes his paper by advocating a boiler house which is designed for the boilers so that the building and machinery fit each other as exactly as the propelling machinery fits the hull of a ship. He also advocates plenty of light everywhere, with no dark corners anywhere, and a state of cleanliness should prevail here as well as in the engine room. Cleanliness, with a good supply of white-wash in the the boiler room, is the handmaiden of economy; for it reveals cracked boiler settings, leaky pipes and shiftless firemen.

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Carborundum, which is chemically known as silicon carbide, is a product of the electric furnace, and is made by smelting a mixture of powdered carbon and sand. The result of this smelting is a mass of very hard black crystals which are formed into grinding stones or other articles of similar use. It is one of the hardest manufactured substances known.

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Two alternators are in phase when the position of the armatures with respect to the field poles is the same; that is, when similar armature coils are opposite positive field coils at the same instant. When this condition exists, the electromotive forces of the machines are both positive at the same time and their maximum values occur at the same instant.

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Factors in Gas Engine Development.

The development of the gas engine has passed through a cycle almost similar to that of the steam engine and dynamo. While the very first steam engine that revolved belonged to the turbine form, it was centuries before the steam turbine came again into practical use. The same thing is true of the dynamo; in its earlier forms it gave out an alternating current, which with great ingenuity was straightened out by the commutator and the direct current was used for years before it begun to be replaced with the alternating current.

The gas engine in its earlier days was primarily intended to utilize waste gases. This was the first idea of its inventors, who realized the large amount of waste heat that was being lost in the atmosphere from different kinds of furnaces, and the gas engine seemed to be the only thing which offered any solution to the problem. When, however, the gas engine first began to be used for power, it was considered necessary to have the finest selected anthracite coal to produce gas of the right quality and it was developed in the smaller powers along that line. It was not until those interested in the gas engine went back to their first principles of using waste gases that the gas engine really began to be any great factor in engineering. So long as the gas engine was compelled to use high priced city gas, it could not hope to compete with the steam engine.

The use of blast furnace gases opened up to the gas engine one of its widest fields. It is said that for every 150 tons of cast-iron that are made in the blast furnace, it gives out 21,000,000 cubic feet of gas. In this case, the blast furnace becomes in reality a gas generator and the question might well be asked, when these gases are used to run powerful gas engines, which is the by-product of the blast furnace, the cast-iron or the gases given off?

The producer gas has opened up another field for the gas engine, for, with the aid of the gas producer, the power of the engine is derived directly from the coal. About five years ago, the first practical suction gas producer was put upon the market in Germany, but at the present time, there are a number of firms manufacturing them in this country. The apparatus consists briefly of a generator in which the coal is burned, a blower used for starting the fire and raising the heat in the generator to proper temperature for the production of gas, a coal hopper which allows charging during operation, a vaporizer for the generator of steam, a scrubber, consisting of a coke tower with a water spray for washing the gas, a cleaner, through which the gas is filtered, and a governor, for maintaining a steady pressure throughout the system.

The effect of these developments has been to increase the use of the gas engine for many purposes and while it is not as yet a formidable rival to the steam engine, on account of its many inherent defects, it possesses features of economy which are very attractive and which must necessarily engage the attention of the power user.

Another development of this class of engine is the gas turbine, of which, as yet, little is known, but if it can be made to operate successfully, it should be one of the most efficient and economical machines for converting the stored energy in the coal into useful work.

The Mercury Vapor Converter.

At the present time, one of the important things which is constantly engaging the attention of the electrical engineeer is the transformation of alternating current of high potential into direct current of low potential. This is necessary wherever such apparatus as direct current motors, storage batteries or apparatus used for electrolytic work is installed along the lines of an alternating current circuit.

The usual method has been, and still is, to pass the current through a rotary converter which absorbs the vibrating current and gives out a smooth or direct one. There has generally been more or less dissatisfaction with this method for various reasons and many engineers have looked upon it as a more or less makeshift method which will be used only so long as the kind of circuits and apparatus available makes it necessary.

For illustration, take for instance, street railway practice in some localities. Owing to various conditions, such as the acces-

sibility of fuel and water for the power plant, the generating units must be installed at a certain place and the street car lines must run for miles in perhaps many directions. The condition met with is that since there is still to be found an alternating current motor which will operate successfully for street railway service, direct current must be fed into the trolley wire. This is done by either generating direct current and transmitting it through large feeders to the point of application or else generating alternating current of high voltage and transmitting it through comparatively small lines to rotary converters, which feed out to the trolley line the required voltage and current.

The principal objection to the former is the loss of power in transmitting large currents long distances and the enormous cost of adequate sized cables; and the objection to the latter is loss of power in the converter, cost of the converter and the attention which all revolving machines require. While the latter system has been doing good service and is considered the better practice for long transmissions, the engineer still feels that there is room for improvement.

Attention has been attracted in this direction by the invention of a piece of apparatus, known as the mercury vapor transmitter, which has no moving parts, is comparatively light in weight and demands practically no attention. It consists of a glass bulb somewhat irregular in shape which contains a perfect vacuum and a small quantity of mercury. In small sizes it is said to be working satisfactorily but has yet to be tried for larger work, although in one large city it is about to be tried on an arc light circuit where alternating current is available and direct current lamps have been used.

Its particular disadvantage at the present time seems to be its fragility. A glass enclosed vacuum of any size with a puddle of mercury in it is, at best, a very delicate piece of mechanism. This has been found true of mercury vapor lamps, which are very hard to ship without breaking, and as the mercury vapor converter is only a modified form of the mercury lamp, this same objection must apply. Aside from accidents, any important point would be its natural life.

If, however, it is found that these disadvantages can be overcome, it is probable that the mercury vapor converter will become a widely-used piece of mechanism for many purposes.

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The Unexpected Which Often Happens.

In looking over the many disastrous accidents which have happened to all kinds of machinery during the past year, there is one thing which most of them bring clearly to mind and that is, they were unexpected. Whatever might be said afterwards by persons of the "I told you so" type, there is no doubt that if they were expected, steps would have been taken to prevent them.

The peculiar thing about unexpected accidents or even unexpected discoveries, is that they come to the best informed and the ignorant alike, to the careful engineeer or the engineer who is not so careful. Many years ago in the early days of engineering, Professor John E. Sweet, the well-known inventor and designer, delivered a lecture on this subject, which is just as applicable now as it was then.

Among other things he said: "If we had no experience or knowledge, or no knowledge of the experience of others, everything which happens would be unexpected. It is not so much the unexplainable as the unexpected which attracts our attention, excites our astonishment or disturbs our mental equilibrium. The man who devotes his life to experimenting with practical mechanics is sure to meet with the unexpected or else he is too wise for his generation. Some of us do not care to admit that we were caught with the unexpected, but I beg to expose a few of the many things that have come upon me unexpectedly, in the belief that they may be of use to others, and in the hope that others will explain their experiences, so that we may profit in return."

One of these unexpected occurrences he describes as follows: "An engineer put in charge of our electric light station found the engineers using oil of 26 gravity for lubricating the engines and dynamos. Even when the oil was used freely, the bearings would warm up, and sometimes get hot. It was the practice to increase the quantity of oil as the journals got warmer, and to turn on water when the oil would do no longer. To the engineer's surprise, he discovered, one night, that one of the bearings kept cool; and he noticed also that the oil-cup was feeding only about one-quarter as fast as had been the practice. The happy idea of letting well enough alone, occurred to him, and he found that the bearing continued to run cool; and by experimenting he proved that by feeding little enough oil he could make the other bearings run cool also."

The particular advantage of describing any accident or unusual occurrence around a power plant is to make the unexpected known, so that it will be no longer unexpected but expected and explainable. Many of our best discoveries and inventions were the results of this interchange of ideas.

So long as we do not know it all, so long will the unexpected happen.

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Condensers for Steam Turbine Units.

At the present time, one of the incongruities in a power house where there is a steam turbine installed, is the large size of the condenser equipment as compared with the relative small size of the turbine itself. Surrounded, as it usually is, with its condensers and auxiliaries, the turbine appears to be the least important part of the outfit.

One of the particular reasons for this is the fact that a steam turbine requires a good vacuum for economical operation, and as a good vacuum cannot be produced without using large condensing surfaces and plenty of cool condensing water, it has been the custom to install surface condensers to produce the vacuum required.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

The Valve Hand Wheel and Wrench Question.

EDITOR THE PRACTICAL ENGINEER:

The various discussions on the question of the advisability of using a wrench on hand wheels of valves which have appeared in the columns of "The Practical Engineer," have interested me to such an extent that I have made it a special study during the past few months, which, coupled with an experience of fifteen years in and around the engine room, has

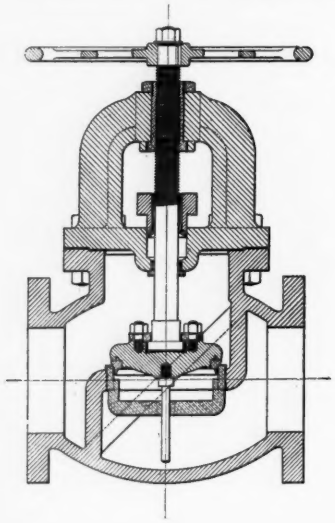


Fig. 1.

induced me to write the following, sincerely trusting that it may find a place in the columns of this interesting paper.

I have always made it a point to "sift to the bottom" any question that arose regarding the engine room, and I trust that the following will be of some benefit to my brother engineers, who have taken the stand for the use of a wrench, in connection with the supposed proper operation of a valve.

Decidedly a wrench should never be used on the hand wheel of a valve, no matter how large or small the same may be, and I, for one, have never used a wrench for this purpose but once in my life, and that was about fourteen years ago, when I had just been promoted to engineer. The valve was leaking slightly, and after I applied a wrench that valve never leaked again, for the simple reason that I had to replace it with a new one.

It is my intention to conclusively show why a wrench should not be used, and I have therefore gone to considerable trouble and expense to obtain the necessary data. The section herewith, Fig. 1, is taken from a Lunkenheimer 8-inch iron body valve, which I have been using for ten years or more. Although a large valve, I have never had any trouble in operating same, as the proportion of the hand wheel in respect to that of the disc is correct, and I never had to exert myself to any great extent in closing same, and procuring a tight joint.

It will be noticed that the seat is ball shaped, which to my notion is by far preferable to either the flat faced, or the composition disc. Now suppose this valve leaked, and a wrench was applied to the hand wheel to obtain a tight joint, what would be the result? It is possible that the valve could be made tight by this method, but decidedly when it is desired to close

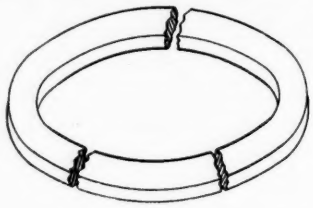


Fig. 2.

the valve again, it will be found that to make a tight joint considerable more force is necessary, and it will not take very many operations before the valve will be placed entirely out of commission, and beyond repair. The proper thing to do in a case of this kind is to take the trouble to regrind same (which is very slight compared with the necessity of replacing a valve), by which means the valve is made as tight as when new.

It is possible that some valves are hard to operate, and the only reasons that I can give for this is that the hand wheels are too small in proportion to the disc, or that the threads on the same are too tight a fit within the threads in the yoke, or that the stuffing box is packed too tight.

Suppose we next consider the valve with the composition disc. If a wrench is applied to a hand wheel of this type of valve, surely I need not tell the engineer what the result would be. This was one of the experiments which I made, and the accompanying sketch, Fig. 2, clearly illustrates the condition of

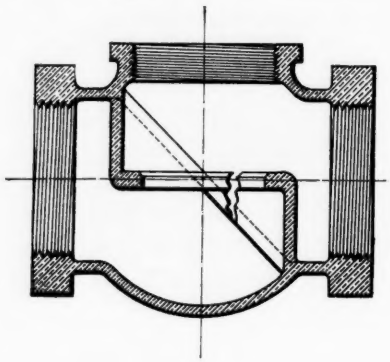


Fig 3.

the disc when removed. A brother engineer and friend of mine, who had fallen into the error of using a wrench in connection with the hand wheels of a valve, showed me a valve body which he was compelled to throw away, simply because of the use of a wrench.

The accompanying sketch, Fig. 3, shows what a large wrench did on the hand wheel of a small valve. It did not take much pressure to crack the body through the diaphragm, and my

friend has since decided not to use a wrench, but to take a few minutes' time and regrind the valve, in preference.

I have installed a small valve for the purpose of experimenting and have used a wrench constantly on the hand wheel. I had this valve only two weeks, and the sketch herewith, Fig. 4, clearly demonstrates what the result was at the end of two weeks. Owing to the unequal pressure on one side of the wheel, the natural tendency was to bend the stem, also the threads wore rapidly, and after two days' use the stuffing box was affected to such an extent that it was impossible for me to keep the valve tightly packed.

Now then regarding the hot hand wheel, I have never had cause to complain about this objection, as the hand wheels on the valves I use have never been so warm as to make it uncomfortable for myself or any one else to handle the same. This may be attributed to the extra long spindle on this make of valve, as will be seen by the sectional sketch, which not only removes the hand wheel farther from the body of the valve,

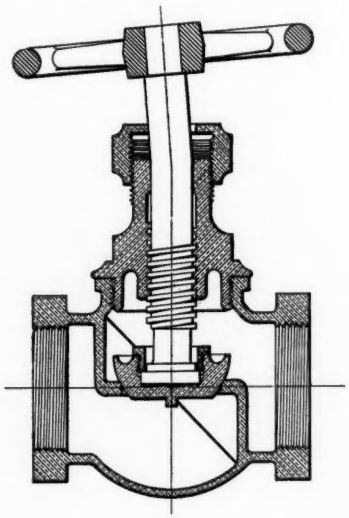


Fig. 4.

but also allows ample room for packing the stuffing box. We will suppose, however, that this is not the case with some other makes of valves used by my brother engineers. Such being the case there are three remedies that they might use—either wrap non-conducting material around the hand wheel, or have a pair of thick gloves within easy reach, or install such valves as will not give this trouble, but in no event should they use a wrench.

In conclusion, a wrench used in connection with the hand wheel is a parallel case with gun powder used in connection with steam to produce more power with which to run the engine. In other words, something is added that is not necessary, and will do more harm than good.

Cincinnati, Ohio. EDWARD MILLER.

A New Reader would like to Say a Few Words About the Valve Subject.

EDITOR THE PRACTICAL ENGINEER:

On looking over the letters in the March number, I see that A. T. has had a few critics but as I am a new reader, I did not see them. I want to say a few words on the valve subject, if you will allow me, as I have a few hundred valves in my plant. We originally had about all the different makes but we found that it paid to buy only the best and stick to it.

There is no need of a wrench; valves from ⅛-inch to 2 inches can be made perfectly tight with one hand; from 2½ inches up to say 18 inches requires both hands, but no wrench. We have at this plant ¾-inch valves working under hydraulic pressure of 500 pounds and I find that the best disc to last is one I get up myself, as I have a reseating machine fixed on an old sewing machine frame. I take out the hard rubber disc and melt in half and half tin and lead. As some of these discs have been in use for the past few years, I must agree with A. T. that the wrench habit is wrong just as much as the habit of using a 24-inch wrench on a man-hole bolt nut or a monkey wrench on a lubricator.

Detroit, Mich. E. J. R.

This Engineer from Scotland Insists upon the Use of the Wrench.

EDITOR THE PRACTICAL ENGINEER:

Have just received the first issue of "The Practical Engineer" in which I see a discussion on "Opening and Closing Valves." What I understand of the wrench habit is a means of closing a valve tighter than can be done by hand by using a wrench, or what we call a bar, say a foot in length, according to the valve.

Although all engineers will agree that the use of a bar is an evil, because broken spindles or bent ones is the result. I have always found that if I wanted to make sure of a valve being tight, I had to use a bar. My experience has been at sea, on the Indian Ocean, but, of course, that does not matter.

Now, A. T., in the March issue, says he fails to see in print where any of those so-called expert engineers give any excuse or good reason for using a wrench. Of course, I do not know what A. T.'s critics have been saying but I can give many instances where a wrench is absolutely necessary.

One of the times when the wrench becomes necessary on board ship is after stopping. Often times every half hour have I had to use the bar for two hours after stopping so as to get the main stop valves on the boilers tighter. After the engine is stopped, then follows the closing up of all connections except keeping the circulating water through condenser. Now in closing up, the main stops are closed and although the stops are hard up by bar, in one-half hour after, I will go and get nearly a half a quarter turn on the circumference further up. I couldn't do this by hand, only by the use of the bar, the wheel being 12 to 16 inches in diameter. For the next three half hours I will go down and get the valves up each time, the amount decreasing each time and continuing until I find I will get no draw whatever.

The reason that the bar is necessary is because the pressure put on by the hands is far from sufficient to close the valve enough; in fact, not only is the bar necessary but a little extra assistance of the knee also. Now, unless this bar is used, the steam finds its way to the condenser and, any one who knows what this means, knows it means, by allowing the condenser to get hot, stoppages at sea for leaky condenser and many other things that follow; prevention in this case being better than any cure.

The reason for having to go two or three times to put up the valves more is because of expansion. Now, on both large and small valves, I have found the bar or wrench necessary to insure tightness, especially when boiler pressure is on the

inside of the valve. This tightness is necessary because—it is no joke to use sea water, to say nothing of extra expense incurred from scale, trouble to keep up steam when scale is formed and last of all, it is the worry from all these and many other things that kill.

So I may add that using a wrench is a necessary thing in my profession at sea, and I feel it my duty to write what I know about using a wrench. On board ship the wrench always has a fixed position, so that all engineers know where to find it and while we would like to do without the wrench, for, when not used with proper judgment, a bent spindle is the result, yet it is necessary to insure tightness.

I may also add that aside from the bent or broken spindles, for the sake of fresh water, packing, joints, coal, pulling cold water in boiler and other things and also to be saved from worry, use the wrench.

Argyleshire, Scotland. EDWARD MACKAY.

A Low Water Boiler Explosion.

EDITOR THE PRACTICAL ENGINEER:

The accompanying illustrations show several views of a boiler whose explosion was undoubtedly due to low water. This boiler was of the locomotive type, and was used as one of a battery supplying steam for a large manufacturing company, by whom it was built. The barrel of the shell was 60 inches in diameter and was of 1-16-inch plate, the total length being 25 feet. The boiler had a grate surface of 64 square feet, the plates forming the water legs being spaced by a wrought-steel mud ring, 4 inches wide. The crown sheet was 5-16-inch thick and was supported by girder stays or crown bars spaced at intervals of 6 inches.

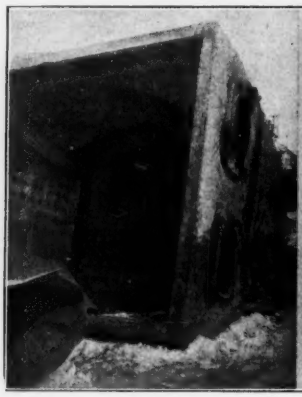


Fig. 1.

Fig. 2.

Fig. 3.

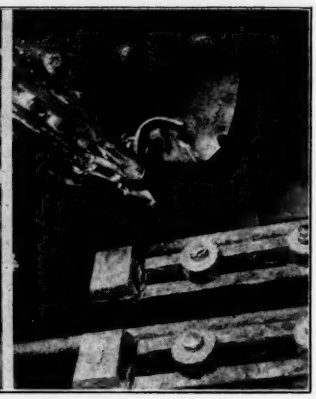


Fig. 4.

Fig. 1 shows the general appearance of the firebox end of the exploded boiler. It will be seen that the initial fracture must have occurred at the rear end of the crown sheet, in the joint by which it was held to the back sheet of the firebox. Immediately following the failure of this joint, the crown sheet was forced inward, or rather, downward into the furnace, neatly stripping all the crown stays from the sheet and tearing the side sheets of the firebox in a diagonal direction, as if they had been of paper. The crown sheet was bent over until it lay flat against the rear tube sheet. The volume of steam and hot water thus released, reacting with terrific force upon the top of the boiler, lifted it from its setting and hurled it end over end a distance of some two hundred feet. One of the fire doors, with its red-hot protecting plate, was thrown considerably further, through the side of a coal breaker, setting fire to the latter.

Fig. 2 illustrates the appearance of the rear furnace sheet. A portion of it is torn downward and practically doubled back on itself. The appearance of this plate confirms the supposition that the initial fracture occurred along the line of rivets joining the crown sheet to the rear furnace sheet, since the plates are torn in every direction away from this seam.

The ends of the crown-sheet staybolts, just after the explosion, presented a peculiar appearance in many instances. Where they had been torn off, the end presented a whitish fracture, surrounded by a dark ring, giving the impression that the bolts had been slightly fractured at some time previous to the explosion and that under the sudden stress thrown upon them by the failure of the joint mentioned, they broke easily.

A closer view of the corner of the crown sheet, shown in Fig. 2, is given in Fig. 3. The plates are badly twisted, but the fractures do not show any coarse crystallization or granular structure such as one might look for in an overheated plate. The supposition remaining is that the overheating was not of such a degree as to alter the construction of the steel plate, yet sufficient to weaken it to the breaking point.

It is certain that the explosion was due to mismanagement rather than to poor materials or bad workmanship. The fractures in the side sheet and back tube sheet, a detail of which is shown in Fig. 4, as well as all other fractures, show that the material is excellent. But, further than this, the appearance of the ends of the crown bars points to mismanagement in carrying excessive pressure. On a number of the bars there appeared to be a slight polish at the point where they rested, as though there had been repeated movement of the ends such as would be produced by bending of the bars at the centre due to variable steam pressures throughout a considerable period of continuous working.

Scranton, Pa. X. N. TRICK.

Groaning in Steam Pumps. Remedies.

EDITOR THE PRACTICAL ENGINEER:

I notice in the April issue of "The Practical Engineer" that some one wants to know the causes of groaning in steam pumps. I herewith give a list of troubles I have had with groaning in pumps which may be of some interest to the inquirer.

A single-acting boiler feed pump made a groaning noise in the steam cylinder very near the whole stroke and I had to feed graphite into the cylinder to stop the noise. Upon examining the cylinder, I found that the piston would bear on the bottom of the cylinder too hard, so that no oil could get to it, and upon examination of the piston rod, I found it to be bent a little After the rod was straightened and the pump started, the noise was stopped.

At another time, one side of a small duplex pump made a groaning noise in one of the steam cylinders and upon examining the piston and rod I found a ring made out of babbitt metal in the bottom of the stuffing box and this babbitt ring was a little too large on one side and in putting the ring into the stuffing box, it pressed the piston rod to one side. The result was that when the piston reached the stuffing box end of the stroke, it would be pressed against the cylinder walls and make a groaning noise. The reason the babbitt ring was put into the bottom of the stuffing box was because the hole in the stuffing box was too large for the piston rod and packing could not be kept in the box, as it would work into the cylinder. After a ring was made which fitted the piston rod and stuffing box, the noise could not be heard any more.

Another pump made a groaning noise in the steam cylinder. Upon examining this pump, I could find nothing wrong with it except that the edges of the packing ring were very sharp and I thought perhaps this was the cause of the trouble, as my idea was that these sharp edges would scrape the oil from the walls of the cylinder. I dressed the edges with a file and when the pump was started again, I had no more trouble.

Another single-acting boiler feed pump made a groaning noise in the steam cylinder at each end of the stroke. Upon examination I found everything in good condition except the valves on the water end, which leaked a little. These valves were of the hot water type so I ground them to a good fit again on a piece of sand paper placed on a piece of flat iron with a smooth surface. When I put the valves back they did not leak and the noise in the steam cylinder had also disappeared. Whether this leaking of the water was the cause of the noise in the steam cylinder, I do not know, but the noise stopped after the valves were tight.

There are many causes for groaning in steam pumps, such as the packing getting too hard in the stuffing box on the steam end, not enough cylinder oil fed into the cylinder, or the packing on the water piston is too tight.

After I renew the packing on the water piston of my pumps, I let the pump make a few strokes, then shut down again, close the valves on the suction and discharge pipes, then move the piston with a bar to see if the packing is too tight or not. If the packing is too tight, I remove some of it and with this method, I am sure that the cylinder will not be cut.

Milwaukee, Wis. H. J.

Can This be Done?

EDITOR THE PRACTICAL ENGINEER:

I have noticed in your valuable paper that many of your readers have asked for mechanical assistance and have received same and I have read these answers with great care, as they are full of knowledge.

Now, I should like to know if this could be done to good advantage: I am running a 45 horse power steam engine and one 20 horse power gasoline engine. The steam engine is connected with an 8 x 6 air compressor. The distance between the air tank reservoir and air compressor is about 75 feet and from the reservoir it is sent to several different places in the factory, a distance of from 15 to 75 feet.

This air tank reservoir is standing near the gasoline engine and I would like to know if the exhaust pipe from the gasoline engine could be connected with advantage to the air tank; that is, with some pipe in the air tank reservoir so it would have free passage of the gases and reheat the air. How could it best be done?

Minneapolis, Minn. C. A. T.

Water Columns Should be Renewed Every Eighteen Months.

EDITOR THE PRACTICAL ENGINEER:

In reading over the account of the Brockton explosion in "The Practical Engineer," I notice that it said that there was plenty of water in the boiler before starting to run. Well, this may have been all right, but at the same time the water column might have been filled with scale like most water columns are, after they have been in use for some time. I think it would be a good idea for every engineer, marine or stationary, to change and make all new fittings for his water columns every 18 months. I make a new column every year and it only costs a few cents. I am not writing this because I know the whole thing, but it is from my experience, and I think that if water columns were more often renewed, there would be less explosions.

Racine, Wis. C. H.

Not Hot Air but Compressed Air.

EDITOR THE PRACTICAL ENGINEER:

We 'uns will admit that we have been interested in reading the controversy between Brother Wakeman and Brother A. T., but I think that the nickel plate has worn off, so that we'uns have to get busy at other things and will chip in something that we'uns hope will crank the switch over and run the controversy on to a more useful track.

We'uns have in charge a couple of air compressors and we'uns are puzzled sometimes to know just what power they are turning out. Now, Mr. Editor, if Brother A. T. and Brother Anybodyelse will give we'uns a formula for doing the following, they will confer a favor on one humble reader.

I will turn to we'uns log book under date of December 27th for data. These machines usually run 12 hours per day, but on this occasion No. 1 engine ran 6.5 hours and No. 2 engine ran 11 hours. Engine No. 1 has a volumetric capacity of free air, when running 92 revolutions per minute, of 1900 cubic feet per minute and when compressing the above amount to 90 pounds pressure gives out 3.5 horse power per revolution. No. 2 engine has a volumetric capacity of free air of 4725 cubic feet per minute, when running at 75 revolutions per minute, and when this amount is compressed to 90 pounds, it requires 9.46 horse power per revolution.

On this occasion No. 1 engine was averaging 74.5 revolutions per minute and No. 2 engine 57.78 revolutions. What is the average horse power for the day?

Sault Ste. Marie, Mich. H. L.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Answer to J. M.'s Question: "What is the Matter With This Card?"

EDITOR THE PRACTICAL ENGINEER:

In answer to the question asked by J. M., Danbury, Conn.: "What is the matter with the indicator card?" shown in the May number, I would say that I do not agree with B.'s theory at all, for the reason that the undulations take place at the point of rest of the indicator piston. A's theory is correct, I think, so far as the fling of the moving parts is concerned but I would like to say that the undulations are not in the steam line as stated in the question. They are in the compression line.

There is too much compression for the reason that the line is carried above the steam line and indicates a late admission, according to the card. I think if J. M. will give his engine valves a little more lead he will have a good card.

Grand Rapids, Mich. G. R. K.

Answer to J. A. J. About Black Varnish.

EDITOR THE PRACTICAL ENGINEER:

In answer to J. A. J., of Nazareth, Pa., who has had trouble with his arc lamp casings, I would suggest to him that he soak his old lamp casings in potash water (1 pound of potash to 5 gallons of water); then rinse off well in clean warm water. This will take off all the old enamel and leave a good smooth surface. He can get a Japan gloss finish in most any hardware store. I could not advise him to try to make any enamel as it would be dangerous and expensive, unless he wanted to make 20 gallons or more. I have made barrels and know many different mixtures.

Boston, Mass. W. A. R.

Setting Corliss Engine Valves.

EDITOR THE PRACTICAL ENGINEER:

In the April issue of "The Practical Engineer," you answered the question: "How do you set the valves of the Corliss engine?" You say that if the connection of the hook rod is below the centre of the wrist plate, turn the eccentric in the opposite direction to which the engine is to run when setting the eccentric for lead. Is this correct?

I have always understood that the eccentric should always be turned around on the shaft in the direction in which the engine is to run, regardless of whether the connections are above or below the centre or whether the connections to the rocker arm reversed the motion or not, because that part of it would take care of itself. I bring this up because it is rather misleading.

New Bedford, Mass. F. W. C.

Whenever the hook rod of a Corliss engine is connected above the centre of the wrist plate, which is usual on all single eccentric engines, the eccentric is always turned in the direction in which the engine is to run, but when the hook rod is connected to one of the wrist plates below the centre, as is often done with double eccentric engines, it can easily be seen that if the eccentric was set in the usual manner it would turn the valve in the wrong direction. It is, therefore, necessary to turn the eccentric in the opposite direction to that in which the engine is to run in order to get the proper motion of the valve. A little investigation with the type of valve gear under consideration will easily determine this.—[Ed.]

Sizes of Tap Drills for Bolts and Pipe Threads.

EDITOR THE PRACTICAL ENGINEER:

Will you please give, through your paper, the size of drills to be used for tapping, both for bolts and pipes, from ¼-inch to 2½-inches.

Manayunk, Pa. C. S.

The sizes of tap drills for different size screws are as follows:

Diam. of Screw.	Tap Drill.
1/4	3/16
5/16	1/4
3/8	9/32
7/16	11/32
1/2	13/32
9/16	7/16
5/8	1/2
11/16	9/16
3/4	5/8
13/16	21/32
7/8	23/32
15/16	3/4
1	27/32
1 1/8	15/16
1 1/4	1 1/16
1 3/8	1 5/32
1 1/2	1 9/32
1 5/8	1 3/8
1 3/4	1 1/2
1 7/8	1 5/8
2	1 23/32
2 1/4	1 31/32
2 1/2	2 3/16

Sizes of tap drills for different sizes of pipe are as follows:

Diam. of Pipe.	Tap Drill.
1/4	15/32
3/8	19/32
1/2	3/4
3/4	1
1	1 1/4
1 1/4	1 17/32
1 1/2	1 13/16
2	2 1/4
2 1/2	2 3/4

If a tighter thread is wanted for any reason, the size smaller tap drill can be used but the hole must be reamed before the tap can be started.—[Ed.]

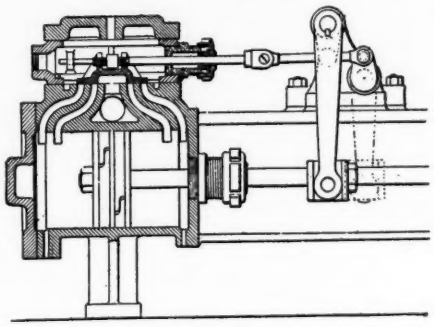
Water in Gauge Glass. Steam Distribution in Single Acting Pump.

EDITOR THE PRACTICAL ENGINEER:

I have just begun to take "The Practical Engineer" and I would like to ask two questions. I think your paper is well named, for it is practical all right and easily understood.

(1). When a water glass is shut off for the night, should the water be blown from the glass or left in?

(2). Enclosed is a sketch of the steam end of a single acting



Steam End of Pump.

pump. When the valve shuts off steam, does the piston continue to travel or does it stop and reverse?

Tewksbury, Mass. L. F. B.

(1). The water should be left in the glass.

(2). In the type of pump shown, the piston reverses when the steam is shut off as the valve has no lap or lead. The indicator card taken from such a pump resembles a rectangle. —[Ed.]

Trouble in Radiator.

EDITOR THE PRACTICAL ENGINEER:

I am in a little trouble and perhaps you may be able to help me. I have two indirect heating coils in my plant that will not heat. Three sections of the coils on the outside will become hot while the centre remains cold. The air valve will blow air and show steam and the return pipe will show the right temperature. What can be the trouble?

Cambridge, Mass. J. M. D.

An article on "Piping Steam Heating Plants" in the February issue of "The Practical Engineer" will answer this question.—[Ed.]

Size of Boiler for a Given Engine. Different Kinds of Horse Powers.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer the following questions through the columns of your paper?

(1). How is the power of a gasoline engine rated?

(2). How do you figure the proper size of a boiler for a given engine? For instance: I have a fifty horse power automatic cut-off engine. What would be the proper size boiler?

(3). What is the difference between indicated horse power, nominal horse power, effective horse power and brake horse power?

St. Louis, Mo. J. A. G.

(1). Since the whole subject of size and weight of explosive engines is still very indefinite, the most reliable way of rating a gasoline engine is according to the brake horse power.

(2). To figure out the size boiler actually required for a given engine, the maximum amount of steam the engine uses per hour should be known. The boiler must, of course, evaporate as much water as the engine uses.

The horse power of a boiler depends upon the amount of water it evaporates per hour, the temperature of the feed water and the steam pressure. If the temperature of the feed water is 100 degrees and the steam pressure is 70 pounds, a boiler which evaporates 30 pounds of water under those conditions is rated at one horse power. This is equivalent to 33,305 thermal units per hour, which is the standard for one horse power. For any other conditions of feed water and steam pressure, by dividing the number of thermal units by 33,305, the horse power of the boiler can be obtained.

An automatic high-speed engine, such as mentioned in the question, would require about 30 pounds of water per indicated horse power per hour when running under full load, so that in this special case, a 50 horse power boiler would be about large enough to run the 50 horse power engine.

If the engine was of a type that consumed only, say, 20 pounds of water per indicated horse power per hour, then a boiler of 34 horse power would run a 50 horse engine, but if the engine belongs to a more uneconomical type and requires, say, 40 pounds of water per horse power per hour, then a 67 horse power boiler would be required; assuming in all the above cases that the temperature of the feed water is 100 degrees and the steam pressure 70 pounds.

In general, it might be stated that while the size of the boiler depends upon the economy of the engine, yet in practice it is usual to make the boiler capacity somewhat larger than the engine capacity for various reasons. The thing to be sure of is that the steaming capacity on the boiler end of the plant should be too large rather than too small.

(3). Indicated horse power is the power of an engine as calculated from an indicator diagram. Nominal horse power is used to express the power of an engine approximately as calculated from its dimensions. Effective horse power and brake horse power is the same thing, since the brake horse power is the actual or effectual horse power measured at the pulley by an arrangement known as a brake or dynamometer. The effective horse power is the difference between the indicated horse power and the friction of the engine.—[Ed.]

Height of Chimneys.

EDITOR THE PRACTICAL ENGINEER:

In your March number you give a rule for finding the area of chimneys but you don't say anything about the height the chimney should be. Will you please state what height the chimney should be in proportion to the size of the boiler?

New York, N. Y. W. C.

When designing a chimney for a given boiler or batteries of boilers, it is usual to fix upon the height of chimney required and then calculate the diameter. When using natural draft it is always advisable to make the chimney as high as possible and regulate the draft with the damper regulator. In order to give the required draft to a steam boiler furnace of about 50 horse power, the chimney should not be less than 65 feet in height and with large batteries of boilers, the height

seldom exceeds 150 feet unless there is higher land or buildings in the vicinity. The kind of coal used also affects the height required; anthracite coals require a higher chimney than bituminous coals. The following heights will give good results: 75 to 100 feet for free-burning bituminous coals, 115 for slow-burning bituminous coals, 125 feet for anthracite pea coal and 150 feet for anthracite buckwheat coal. In different localities these figures will vary, as they may have to be changed to meet certain conditions. A common rule, which is sometimes used, is to make the height about 25 times the diameter .—[Ed.]

Locomotive Boiler. Hydraulic Problems.

EDITOR THE PRACTICAL ENGINEER:

(1). What is the supposed strength of the boiler sheets of a large locomotive boiler? How are the joints constructed? How many rows of rivets? What I want to know is, knowing the diameter and pressure on the boiler, allowing a factor of safety of 3, what would be the thickness of the sheets of such a boiler and what is the rule for finding the thickness?

(2). Suppose I am forcing water through a line of hose 2½ inches in diameter and the pressure at the base of the nozzle is 140 pounds per square inch, what will be the discharge per minute from a 1¼-inch smooth nozzle and what is the rule for finding the discharge?

(3). Suppose I am forcing water through a line of 2½-inch hose, 500 feet long and the pressure at the pump is 200 pounds per square inch, what will be the pressure at the base of the play pipe, using 1¼-inch smooth bore nozzle? Is there any rule for finding this without a pressure gauge at the base?

Baltimore, Md. G. G.

(1). The supposed strength of the boiler sheets, which are made out of mild steel, is about 55,000 pounds per square inch. The joints are lap welded with a double row of rivets. The thickness of the barrel plates vary from 9-16 to ¾-inch. Disregarding any effect which stay bolts might have upon the strength, the tendency to burst can be calculated by the formula $P = (T \times c) \div D$, in which in this case, $T = \frac{5}{8}$-inch, say, $c = 8624$ for double riveted joints and $D = 4\frac{1}{4}$ feet, then P, the bursting pressure per square inch, will equal 1268 pounds. To find the thickness, allowing a factor of safety of 3, the formula becomes $T = 3PD \div C$.

(2). If it is assumed that the 140 pounds pressure is the head available to cause flow through the nozzle and that none of it is absorbed in the 2½-inch hose, the effective head at the entrance to the nozzle then equals 322.5 feet. Based upon a theoretical formula which has been reduced to simple form by the introduction of coefficients obtained by experiment, the formula for the quantity of water discharged in cubic feet per second becomes,

$$q = 6.1d^2 \sqrt{h}.$$

in which 6.1 is the coefficient of discharge based upon experiments of the flow of water through a 1¼-inch nozzle, d is the diameter of the outlet end of the nozzle in feet, and h is the effective head in feet.

In the above problem, $d = .104$ feet and $h = 322.5$, from which $q = 1.07$ cubic feet per second or 64.2 cubic feet per minute which is equivalent to 4012 pounds per minute or 480 gallons per minute.

(3). By far the best method of getting the required pressure is by means of a pressure gauge. There is a rule for finding the pressure but it is exceedingly complicated and consists of a number of factors which have been obtained by experiment on certain lines of hose, so that if the hose mentioned above is rougher or smoother than those from which the factors in the formula were obtained, it is very probable that the calculated result will vary from the actual one.—[Ed.]

Horse Power of Engine and Boiler. Safe Speed and Working Pressure.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following questions in the columns of "The Practical Engineer"?

(1). What is the horse power of a return tubular boiler, 54 inches diameter, 16 feet long?

(2). What is the safe working pressure of the same boiler, plates ⅜-inch thick, longitudinal seams double riveted?

(3). What is the horse power of an engine whose cylinder is 14" x 16", boiler pressure 100 pounds, revolutions 200 per minute?

(4). What is the safe speed limit to run the same engine; fly wheel 6 feet in diameter?

Tacoma, Wash. J. H. W.

(1). About 50 horse power.

(2). The safe working pressure, assuming a factor of safety of 5, plates ⅜-inch thick and double riveted longitudinal seams, is 88 pounds.

(3). Assuming one-quarter cut-off and back pressure of 2 pounds, the engine should give out about 130 horse power.

(4). Assuming 6000 feet per minute as the maximum velocity of the circumference of the fly wheel, 320 revolutions would be the limit. It is probable, however, that the other mechanism of the engine, such as the valve gear, etc., would prohibit this limit being attained.—[Ed.]

How About This?

EDITOR THE PRACTICAL ENGINEER:

Does the dead centre of a shaft turn when the rest of it turns? Some engineers say it does and some say it doesn't. Who is right?

St. Paul, Minn. E. J. S.

A New and Progressive Engineers' Club.

EDITOR THE PRACTICAL ENGINEER:

The Steam Engineers' Club of Louisville was organized March the 18th, 1905, with the following officers: President, George Schweitzer; Vice-President, G. W. Brown; Corresponding Secretary, Edw. Kern; Recording Secretary, Thomas J. Dolan; Financial Secretary, W. E. Stanley; Treasurer, Dave Scott; Conductor, Chas. Koch; Doorkeeper, John McDermott.

PREAMBLE.

This Club shall at no time be used for political or religious purposes; neither shall it take part in any strike or interfere in any way between its members and their employers. Its meetings shall be devoted to the business of the Club, and the education of its members in the science of steam engineering.

Its aims and objects are friendship, education and prosperity; in friendship, we want to know each other and be able to tell our wants and troubles in our engine rooms to each other and give and get advice; in education, we want to better fit ourselves for the position we hold, so we can be and make our

work a benefit to our employer or employers. In our opinion, a man is never too old to learn something. In prosperity, we all want to prosper in this world, but if we do not work, learn, and educate ourselves, prosperity may not reach us.

This Club is going to issue a monthly Journal, devoted to the interest of engineering, and will contain, along with notes of the Club, advertisements of firms and individuals that are interested in the manufacture and sale of steam engine requirements.

S. R. BALLARD, Editor and Manager.

Massachusetts State Convention.

The Tenth Annual Convention of the Massachusetts State Association of Stationary Engineers will be held in Fall River, Mass., July 7 and 8, 1905. An exhibition of supplies and appliances used in the engineering business will be held, and all manufacturers of and dealers in machinery and supplies are invited to display their goods during the convention.

The members of the committee having the local arrangements in charge are as follows: Thos. F. Harkins, Ernest Place, Owen Williams, Lebeau Grundy, A. B. Winters, Eli Howarth and M. H. Harrington. Communications should be addressed to Ernest Place, Secretary, 172 Eastern Avenue, Fall River, Mass.

The A. O. S. E. Convention.

Supreme Chief Engineer, H. M. Trout, has issued his official call for the Annual Convention of the American Order of Steam Engineers, to be held in Philadelphia, June 12th, 13th, 14th and 15th. However, the local engineers have gone ahead with their plans and are now ready and waiting for the date and the delegates to arrive. The Convention is to be held in Harmonie Hall, 525-535 North Eleventh Street, and the headquarters for delegates and visitors will be at the Windsor Hotel, Filbert Street above Twelfth.

The exhibition of supplies to be given in connection with the Convention promises to be a decided success, for all the spaces have been sold and manufacturers desirous of exhibiting their products are urging Secretary Harry Myers to find room for them.

The programme for entertaining the delegates is an elaborate one. Monday, the 12th, there will be two sessions of the Councils; Tuesday, there will be a business session in the morning and a boat-ride on the Delaware River in the afternoon; Wednesday will be devoted to business, which will be followed by a grand banquet on Wednesday evening.

The exhibition hall will be open every evening for the reception of visiting engineers and it is anticipated that a large number of engineers will be present each afternoon and evening.

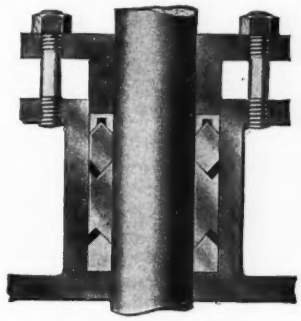
American Society of Refrigerating Engineers.

The American Society of Refrigerating Engineers, which was organized December 5, 1904, have just issued their first year book. It contains a list of the officers and charter members, together with the constitution and by-laws of the organization. John E. Starr is President; H. B. Roelker and P. D. C. Ball, Vice-Presidents; Walter C. Reid, Treasurer; and William H. Ross, Secretary. Any engineer interested in refrigeration can obtain a copy by addressing W. H. Ross, 256 Broadway, New York City.

The Improved Law Metallic Packing.

Among the many qualifications which the packing in a stuffing box of an engine must fulfill, are elasticity, low coefficient of friction, absence of abrasive effects and capacity to absorb and prevent leakage, and, at the same time, be efficient and durable.

The Law Metallic Packing, a section of which is shown in the accompanying illustration, is the invention of an engineer of many years of active and practical experience with steam, air, water, ammonia, oil and gas, and his experience along these lines, together with the knowledge of the necessary qualifications, has resulted in the production of the packing shown herewith. It has been in use in New York City and Brooklyn during the past eight years in its original form, and has given general satisfaction, but it has not been introduced outside of these cities except in a few instances where it has been recommended by engineers who have used it in these places. It has been greatly improved during the past year, and new patents have recently been granted, and it is now presented to all engineers on land and sea for their careful consideration.



Law Metallic Packing

The packing consists of a series of semi-metallic rings, so constructed that the upper and lower rings are forced against the walls of the stuffing box, and the intermediate rings against the rod, when the glad is slightly set up. The annular spaces around the rings, and the spaces caused by splitting the rings, allow the condensed steam and the lubricant used to absolutely prevent heating of the piston rod and rings; as this condensation is held in suspension and keeps them cool. The rings are interchangeable and should one become worn more than another it can be replaced by a new one; this process is a simple one and can be done readily.

As regards the efficiency of the packing, it will be noticed that the frictional bearing of the packing on the rod is only one-half the depth of the stuffing box, thus reducing the friction on the rod. The packing also permits of lubrication and, at the same time, is surrounded by condensation, which not only lessens the wear on the piston rod, but also decreases the friction and increases the efficiency of the joint.

The packing can be used for steam, water, air, ammonia, oil or gas, for stationary and marine engines, pumps, compressors and valve stems. Any further information can be obtained by addressing the manufacturers, Law Metallic Packing Co., 38 Court Street, Brooklyn, N. Y., who will be pleased to give further details, and a list of the many plants where it is now in use.

A New Type of Water Tube Cleaner.

A device for cleaning water tubes that is fundamentally different from anything yet made is shown in the accompanying illustration. This device has been named the "Demon" by the manufacturers and consists essentially of two parts; viz., a new form of scale-cutting tool and a new and powerful form of motor to drive this cutter. The motor belongs to the general class of rotary engines, but differs from most of these in the essential feature, that it has a central shaft and is free from all valves. This motor must not be confused with the turbine, as it bears no resemblance to that form of motor, either in design or operation.

The "Demon" Water Tube Cleaner

The "Demon" is designed to operate by water, as this is the most available motive fluid, and the exhaust water is used for washing away the loosened scale. The inlet and exhaust water is taken care of by properly arranged ports. The pistons of the motor, which are three in number, are attached to the shaft, and each in turn automatically projects across the cylinder, thus forming a partition between the inlet and the exhaust ports, which the motive fluid must push forward before it reaches the exhaust ports. As no water can reach the exhaust until the piston has passed the exhaust ports, the water consumed is directly proportional to the speed at which the machine is revolving. When the machine is working on unusually heavy scale, the speed and the water consumption are both somewhat reduced; but the pressure on the piston and therefore the driving force increases. By this means, the shaft is given a constant and positive rotary motion, and the force available for rotating the cutters is several times as great as the pressure of the water supply.

Another important advantage claimed for this machine is that having produced a motor of this great power, a form of cutter can be used entirely different from anything else designed for this work. The cutting tool in this machine is designed to cut the scale, in contradistinction to grinding the scale, as is done by the small grinding cutters used on the turbine form of motor. In the "Demon," three cutters with tooth-like edges are attached to a heavy head, the latter being directly attached to the shaft of the cleaner. These cutters are journaled to the head at the front ends, and slide in grooves at their rear end. These cutters are not thrown out by the centrifugal force, but are forced out by powerful springs, so that they engage the scale in a positive manner. Their action on the scale is neither of a chopping nor a grinding nature, but that of a direct-cutting tool.

In order to prevent any possible injury to the tubes, and also to relieve the cutters of any friction and wear after the scale has been removed, the outward movement of the cutters is limited by properly-arranged stops. By this arrangement, the cutters can be set that the outside diameter of these cutters in their rotary movement is just equal to the inside diameter of the tube which is being cleaned. The motor or body of the cleaner is properly centered in the tube by six centering lugs, which insure thorough and uniform work by the cutting tool on all sides of the tube.

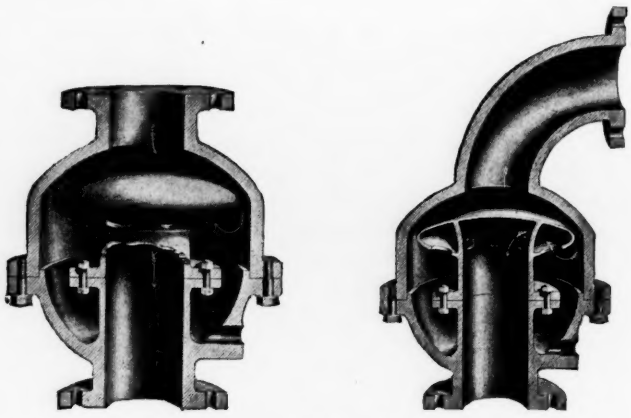
The cutters are so made that they can be easily renewed and at a slight cost. The manufacturers state that they have taken especial care in the proper designing of the parts and the selection of the material used. The journals of the shaft are so constructed that no lubrication is necessary. The most approved forms of roller bearings, made of the best hardened tool steel, are used. All wearing surfaces are made as large as possible and of hardened tool steel. The whole design of the machine is such as not only to produce a powerful and rapid cleaner, but to do away with the necessity of repairing at short intervals. An examination of one of the "Demon" cleaners after it had cleaned 15 140 horse power water tube boilers showed no appreciable wear on any part of the machine with the exception of the cutters.

This device has been designed and is owned and manufactured by the General Specialty Co., of 75 Carroll St., Buffalo, N. Y., from whom additional information on the above can be secured.

Lindstrom's Superheater Steam Separator.

After years of experimenting with steam separators, Mr. John T. Lindstrom, of 216 S. Third Street, Allentown, Pa., has brought out a new separator which he claims will in all cases remove the condensation from the steam before entering the engine cylinder, and, at the same time, slightly superheat it above its saturated point.

As a result of this experimenting, and his wide experience as an engineer, the steam separator shown in the accompanying illustration has been produced. The casing is made out of close-grained cast-iron in two parts, which are fitted together with ground joints, which insures them being steam tight. The lower part of the separator has a nozzle cast in it and on this nozzle the separator is placed.



The Lindstrom Superheater Separator

This separator is cast in one piece, the upper surface of which is smooth and rounded. On the underneath side there are eight openings and opposite each opening there is a web which is cast in. The steam enters the top of the apparatus and comes in contact with the smooth surface on top of the separator. The steam is made to take an irregular course after striking this surface; it must curve down and around the knob-shaped

top, through the holes in the bottom, and around the webs opposite the holes, before it can again enter the main steam pipe. The water of condensation is carried away by a drip pipe, which has its connection at the bottom of the separator. The webs in the separator are also useful for separating any impurities that may come from the boiler with the steam.

As the steam in passing through the separator is surrounded with live steam, it can be seen that the tendency of the dry steam in passing through the separator is to become superheated, and tests are said to have shown that this is the case. These separators are made in all sizes and are installed on 30 days' trial.

Two alternators have the same frequency when the number of alternations or reversals of their electro-motive forces in one minute is equal. This requirement is fulfilled when the number of poles multiplied by the revolutions per minute is the same for each machine.

New Books.

Handbook on Engineering, by Henry C. Tulley. 950 pages, 410 illustrations and 50 tables. Flexible black leather cover. Fourth edition, revised and enlarged. Published by Henry C. Tulley and Co., Wainwright Building, St. Louis, Mo. Price, $3.50.

The object of the author in preparing this work has been to present to the practical engineer a book to which he can refer for information regarding every branch of his profession. An experience of over 25 years with all kinds of engines, boilers, pumps and other kinds of machinery has enabled Mr. Tulley to give in his book the kind of information most needed by men having charge of steam engines of every description and what they can understand and use.

A few of the many things included in the book are the elementary principles of electrical machinery; types of generators and motors; switchboard, distributing circuits and switchboard instruments; electric motors; instructions for operating and installing slow and moderate speed generators and motors; why commutator brushes spark and why they do not spark; instructions for installing and operating apparatus for arc lighting; incandescent wiring calculations; description, care and management of steam engines; setting valves for different types of engines; what to do when taking charge of a steam power plant; use of the indicator; economy and operation of steam engines; care and management of steam boilers; construction and strength of steam boilers; water tube boilers; the steam pump; injector and inspirator; principles of mechanical refrigeration; practical questions usually asked engineers when applying for license; electric and hydraulic elevators; belts and rope transmission; air compressors; alternating current machinery.

All these subjects are explained completely and concisely, and as a reference book it is quite valuable. This revised and enlarged edition has many new features which commend it.

Alternating Current Machinery, by William Esty. Size 6½ x 9½. Bound in three-quarters red leather. 415 pages and 380 illustrations. Published by the American School of Correspondence. Price, $3.75.

This book has been prepared with the special object of giving the beginner, the practical electrician, and the central station man a knowledge of alternating current apparatus and so that he may know how to operate it intelligently. It contains no mathematics higher than trigonometry so that the practical man of limited education can understand it.

In the opening chapters, the essential features of the source of alternating currents, the alternator, alternating current terms and problems are taken up, after which commercial types of alternators, synchronous motors, the transformer, the rotary converter, the induction motor, switchboard and station appliances, and lightning arresters are described.

It is very clearly written and the illustrations are numerous; graphical and geometrical explanations are used rather than mathematical ones whenever possible and the book is filled with a large number of examples which illustrate what has gone before.

Steam Pipes; Their Construction and Design, by William H. Booth. Size 5½ x 8½. 187 pages and 62 illustrations, with numerous tables. The Norman W. Henly Publishing Co., New York. Price, $2.00.

This book fills in a deep gap in scientific literature, as there has been very little written on the practical side of steam pipe construction. Steam piping to-day is such a costly item and the successful operation of a large plant depends so much upon it, that the problem of minimum cost with maximum efficiency becomes very important.

The contents of the book describe the duty and object of pipes, the flow of steam through them, materials of pipes and joints, arrangements to allow for expansion, strength of pipes, pipe joints, pipe supports, erection and general arrangement, valves, methods of drainage, separators, exhaust heads, pipe covering and superheated steam.

The tables of flange diameters, bolts, centre lines, sockets and joints are very useful, and in connection with the description of the erection of steam pipes they should give information upon many doubtful points which are encountered in the design and erection of any complex system of piping.

Gas Engine Design, by Charles E. Lucke. Size 6½ x 9½. 254 pages and 150 illustrations. D. Van Nostrand Co., New York. Price, $3.00.

The purpose of this book is to present in a compact form those principles which underlie the design of gas engines, together with reliable data on the subject, for the use of those engaged in building this kind of machinery.

It is divided into three parts. The first part treats of the power, efficiency and economy of the exploding gas engine. The second part contains the data and methods of determining the stresses in the various parts and the number and arrangement of cylinders for certain conditions. The last part deals with the dimensions of the parts to resist the stresses in such a manner as to show between what limits every principal dimension of the engine should be.

For the designer who, of course, is supposed to understand all the principles of the gas engine, it will prove valuable and as a text book in technical schools and colleges, where all the higher mathematics are understood, it will, no doubt, have extended use.

Stirling; A Book on Steam for Engineers. Size 8 x 10½. 250 pages, 63 tables. Well illustrated. Published by The Stirling Company, New York. Gratuitous to customers.

This well printed book is full of good information which is useful in the practice of steam engineering. It deals with the construction, care and management of the Stirling Water-Tube Safety Boiler; the properties of heat, air, water and steam; impurities in boiler feed water; heating of boiler feed water; saturated steam data; methods of determining moisture in steam; flow of steam through pipes and orifices; superheated steam; principles of combustion; fuels for steam boilers; heating value of fuels; chimneys and drafts; analysis of flue gases; method of making boiler tests, and much other useful information necessary around the boiler room.

Each of the above subjects is clearly described and it should make a most useful handbook for any engineer who manages boilers and who wishes to get out of them the best efficiency that is in them.

Flow of Steam Through Nozzles, by A. Rateau. Size 5 x 7½. 75 pages, with numerous plates and tables. D. Van Nostrand Co., New York. Price, $1.50.

Since the steam turbine has attained such a prominence in steam engineering circles, all eyes are naturally turned toward the fundamental problem of the proper design of nozzle or passage which shall permit the pressure in the steam to be transformed into useful work with the least amount of lost energy.

The practical advance of the turbine has been so fast that reliable data on the action of steam in them has been scarce. Prof. Rateau has attempted to supply this deficiency in his book, and much of the data is the result of his investigations when he was beginning his study of the steam turbine and the manner in which he has presented his results should be a help to others who are experimenting along that line.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Technical Publicity Association is a new organization of advertising men in charge of the publicity departments of the large engine and kindred machinery manufactories including such concerns as the International Steam Pump Co., Cameron Steam Pump Co., Allis-Chalmers Co., De La Vergne Refrigerating Machine Co., Westinghouse Company, Sprague Electric Co., General Electric Co., Crocker-Wheeler Co., and other large concerns. Mr. Geo. H. Gibson, Manager of Publicity for the International Steam Pump Co., Harrison, N. J., is Secretary.

A large new addition is now being made to the plant of the Keystone Lubricating Co., at 20th and Alleghany Ave., Philadelphia. The largest portion of the new building will be used as an annex to the offices of the Company, and will give sufficient room to accommodate a largely increased office force, which will facilitate the handling of orders and correspondence. This is something that the Company has been badly in need of for a year past. The rapid growth of this concern in a few short years affords a striking illustration of present-day commercial possibilities, when founded upon merit and supported by modern methods. Less than a decade since, Keystone Grease was almost unknown. Now it is known and used in every country on the globe, and its goodness is proclaimed by engineers of all nations. The manufacturers are justly proud of their success, which they attribute to the excellence of their grease, to a liberal distribution of samples and to heroic advertising. They offer to send a sample can of Keystone Grease and a Keystone Brass Cup free to any engineer or steam user, upon request.

Rickard's Corliss Engines have not been extensively used outside of their home city, but here in Philadelphia where they are known, especially in the textile districts, the engineers speak very highly of them, many claiming that they are the best Corliss engine made. The manufacturers of this excellent engine have just issued a new catalogue, a copy of which they will send to any reader of "The Practical Engineer," upon request. Address, Corliss Engine Works, 4041 N. Fifth St., Philadelphia.

The New York Safety Steam Power Co. have removed to the Engineering Building, 114 Liberty St., New York.

The Dearborn Drug and Chemical Works have signed a long lease for a suite of six offices, comprising the northwest wing, on the eighteenth floor of the new Barclay Building, 299 Broadway. This gives a north, west, and south view overlooking all of New York Harbor, North River, shores of New Jersey, and uptown New York; one of the most beautiful bird's-eye views in the city. When visiting New York do not fail to call at the new Dearborn offices. The selection of this new location became necessary due to the great increase of business in exports, marine, and through the branch offices at Havana, Boston, Philadelphia, Buffalo, etc., all of which come under the New York office direct. It is the Company's intention, within one year, to establish complete analytical laboratories at New York to relieve the Chicago laboratories of the marine and eastern work. Arrangements have been made with the owners of the building to provide suitable quarters for this purpose above the offices, with private stairs connecting same.

Davidson Steam Pumps have for many years enjoyed a reputation for the highest excellence. No steam user can afford to continue using a pump that is in bad repair; it is too wasteful; nor can any steam user afford to purchase any other make of pump until he has investigated the Davidson. An illustrated circular will be sent to any one interested, upon receipt of request. Address, M. T. Davidson, 141 Broadway, New York City.

The "Vigilant" Feed Water Regulator is comprehensively described and illustrated in a catalogue recently issued by Chaplin, Fulton Co., 32 Penn Ave., Pittsburg, Pa. Write for a copy, if you are interested.

Green, Tweed & Co., 17 Murray St., New York, are offering to send one of the New Improved Rochester Automatic Lubricators with all connections for thirty days' free trial. If at the end of that time you are not fully satisfied that you are securing good value and the best lubricator made, you can send it back at their expense. This is an exceptionally liberal offer by a thoroughly responsible concern and one which it will pay any engineer to accept. These lubricators are now in use in thousands of the best plants in the country and are giving universal satisfaction and saving their cost in oil times over, besides insuring positive lubrication.

The main offices of the Dearborn Drug and Chemical Works, at Chicago, have been removed from Rialto Block to Western Union Building, where they will occupy much larger quarters. This move was made necessary by the constantly increasing demand for Dearborn products.

Mr. Thos. G. Keogh, of New York, formerly with Jas. L. Robertson & Sons, and later with the Standard Gauge Co., has accepted a position as travelling representative with Messrs. Manning, Maxwell & Moore, who control the Ashcroft Manufacturing Co., the Consolidated Safety Valve Co., the Hayden & Derby Manufacturing Co., and the Hancock Inspirator Co., all of which are well known to the steam using public. Mr. Keogh is an old favorite with many of our engineer readers and will have the best wishes of all for a magnificent success in his new position.

The Smith Pipe Clamp is becoming quite a favorite among engineers. Mr. Clifford Smith, the manufacturer, reports enormous sales throughout the United States during the past month. This device, so simple in construction and yet so effectual in its results, appeals to the engineer, who must act quickly in emergencies. To those engineers who have not yet used this clamp, an illustrated circular and a neat souvenir will be gladly mailed.

The William Powell Co., of Cincinnati, Ohio, have just issued the 8th edition of their illustrated catalogue. It contains a price list of nearly all kinds of steam brass goods and specialties used around a power plant. The back part of the book, which is of pocket size, contains many useful rules and tables. A postal card mentioning "The Practical Engineer" will bring one of these books to you.

The Ashton Valve Co., of Boston, have removed their New York office to 128 Liberty St., where they will carry a stock of their high-grade pop safety valves, gauges, etc., and will be pleased to receive calls from their friends and patrons.

The Rock Island Arsenal, at Rock Island, Ill., has recently purchased a large oil filter from the Burt Manufacturing Co., of Akron, Ohio.

The Garlock Packing Co., of Palmyra, N. Y so well known to our readers, was recently incorporated under the laws of New York State with a capital of one million dollars, all the stock of which is owned by the old partners, Mr. O. J. Garlock, E. R. Nichols and F. W. Griffith. This business was established in 1887

Preserve Your Commutator

with Fifield's Commutator Compound. Positively prevents cutting and sparking and will not gum the brushes.
30 cents per stick. $3.00 per dozen. Sold only by

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A LARGE
Diagram
OF THE
Corliss Engine

PRINTED ON EXTRA HEAVY PAPER

Just the thing for those who want to learn more about the Corliss Engine. Size, 13 in. x 19 in.

PRICE. 25 CENTS

A Large Longitudinal Engraving showing the relative position of reciprocating and rotating parts for each 15 Degrees of the circle with the relative positions of the Piston, Steam Valves, Exhaust Valves and Wrist Plates when cut-off takes place at one-fourth stroke. Reach rods and Rock-shafts. The Circle explained. Wrist plates and Eccentrics, etc., etc.

Spon & Chamberlain
Publishers of Books for Engineers
Department P. E., Liberty Building
NEW YORK, U. S. A.

and it long since reached enormous proportions. Heretofore the business has been conducted as a co-partnership. There will be no change in name, ownership or management. It is strictly a close corporation, none of the stock being for sale. Mr. Garlock is president, Mr. Griffith vice-president and treasurer, and Mr. J. H. L. Gallagher, secretary.

The Keystone Lubricating Co., of Philadelphia, have opened an office in New York City, Room 205, 253 Broadway, with Mr. Wm. F. Bilyeu in charge.

The entire plant of the Phillips Insulated Wire Co., of Pawtucket, R. I., has recently been equipped with Sterling force feed lubricators. All of these lubricators, except one, were installed on the engines and pumps of the new plant. The other was placed upon the engine in the old shop, and the engineer has reported that by its use he is getting better lubrication with one pint of oil, whereas in the past he has been using three pints for the same length of time, fed through a sight feed lubricator. This certainly is a strong recommendation for force feed lubricators.

The Williams Gauge Company, of Pittsburg, Penna., wishes to announce that their branch offices, located as follows, will be pleased to receive any inquiries for catalogues and prices from this date onward: 39 Cortlandt Street, W. D. Carpenter, Mgr., New York City; 195 Fort Hill Square, J. A. Mitsch, Mgr., Boston, Mass.; 312 Bourse Bldg., R. M. Huston, Mgs., Philadelphia, Pa.; Times Dispatch Bldg., G. A. Inman, Mgr., Richmond, Va.; First National Bank Bldg., J. I. Blount, Mgr., Birmingham, Ala.; Commercial National Bank Bldg., E. H. Abadie & Co., St. Louis, Mo.; 117 New Montgomery Street, J. C. Martin, Mgr., San Francisco, Cal.; 175 Main Street, M. P. Wolfe, Mgr., Dallas, Texas.

The Birdsboro Steel Foundry and Machine Co., formerly called the Diamond Drill and Machine Co., is located at Birdsboro, Berks Co., Penna. The change is merely one in name, as the same lines will be manufactured. This Company will still continue to make diamond drills and take contracts for prospecting.

Some of its other products are open hearth steel castings, air furnace iron castings, high pressure steel fittings, semi-steel castings, cupola castings, machine moulded steel gears, machine moulded iron gears, cast-steel pipe fittings, rolling mill machinery, hydraulic machinery, punches and shears, slitting shears, Wagner cold saw cutting-off machines, and Jackson belt-lacing machines. Every department of their plant is extremely busy and they have enough orders on their books to keep them running night and day for some time to come.

The Birdsboro Steel Foundry and Machine Co. desire to thank their many patrons of the Diamond Drill and Machine Co., and to express the hope that the change of name will mean as pleasant if not more pleasant dealings than with the old name. The New York office will be at No. 52 Broadway.

At the annual meeting of the stockholders of the Joseph Dixon Crucible Company, the old board, consisting of Edward F. C. Young, John A. Walker, Edward L. Young, William Murray, George T. Smith, Joseph D. Bedle and George E. Long, were unanimously re-elected. The board of directors re-elected the former officers, namely: Edw. F. C. Young, president; John A. Walker, vice-president and treasurer; George E. Long, secretary.

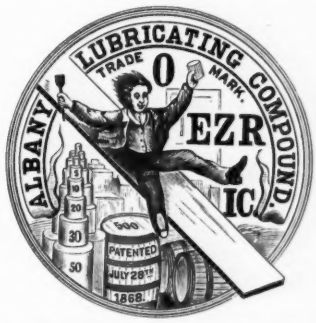
Water softening for boiler feed purposes has become a prime necessity in these days of practical economy and although not so generally practiced as it will be a decade hence, it is making rapid strides. Perhaps the best known concern engaged in this modern enterprise is the American Water Softener Co., 1002 Mutual Life Bldg., Philadelphia. This Company have just published an attractive and interesting booklet describing their method and illustrating its practical operation. A copy will be mailed upon request.

The Lubron Manufacturing Company, 88 Broad Street, Boston, Mass., who have for some time been offering to send free for trial to engineers requesting same, one of their new indestructible Lubron pump valves, inform us that they have received many orders from those to whom samples were sent, and reiterate their offer to send free to every engineer requesting same and giving diameter of pump and size of spud, a sample valve free. These valves are composed of a composition made by a secret process and resemble gutta percha in appearance before being used, but after having been soaked in water a few hours become very pliable. They are said to work equally well in either hot or cold water, oil, brine or ammonia, and in fact, to resist the action of all chemicals.

The Philadelphia Grease Mfg. Co. have removed their Philadelphia office from 147 North Third St. to The Bourse, Machinery Department, where they will be pleased to receive their many friends and patrons. They carry a complete line of greases for every lubricating purpose, any of which can be inspected at their new quarters.

THE ALBANY GREASE TRADE-MARK.

The value of a trade-mark depends largely upon its character and the quality of the goods back of it. That of Messrs. Adam Cook's Sons, 313 West St., New York City, the only makers of Albany Grease, has an individuality peculiarly its own, and which has served to fasten the lubricant it advertises upon the memory of all having to do with the smooth and safe running of machinery. As some one has already said: "The trade-mark forms a link between the manufacturer and the consumer, guaranteeing to the consumer that the goods bearing such mark are made by the same manufacturer as the goods which he previously purchased under the same mark." The trade-mark is therefore a guarantee of quality, and when, as in the case of Albany Grease, the quality is of the highest, the importance of the trade-mark is far-reaching and its consideration a matter of some interest.



It is safe to say that there is scarcely an engineer in active service who does not know Albany Grease and its familiar trade-mark. The mark was first used in 1868 and was designed by two lithographers in the employ of Messrs. Weed, Parsons & Co., of Albany, N. Y., under the instructions of Mr. Adam Cook, the original owner of Messrs. Adam Cook's Sons.

The figure of a boy sliding down a plank, which is the prominent feature of this trade-mark, should be studied in connection with the letters "O-EZR-IC," and these have been the cause of much speculation among users and buyers of Albany Grease. Their meaning is, however, decidedly simple and to the point, signifying "Nothing Easier I See" than to slide down the plank smoothly and without friction when Albany Lubricating Compound is applied. At times the letter "O," which in the trade-mark represents the word "nothing," has been confused with the numbers or consistencies of Albany Grease.

Messrs. Adam Cook's Sons guarantee Albany Grease to save from one-half to three-quarters of the cost of lubricating by oils, and have on file thousands of testimonial letters. Engineers who have used it know that Albany Grease will assure a clean engine room and no hot bearings.

To prove all they claim, Messrs. Adam Cook's Sons will send a suitable Albany Grease Cup with a sample of Albany Grease to test, free of charge or expense.

GRAPHO
SOMETHING NEW
A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
Engineers who have tried same claim it to be the best yet.
SEND FOR SAMPLE
A trial will convince you
AGENTS WANTED
GRAPHO MFG. CO.
Cor. Frank and Commercial Sts.
ROCHESTER, N. Y.

Wanted A few good and competent engineers along the Ohio, Mississippi and Kanawah Rivers, to sell the best thing on earth. This can be done after working hours and between times. Address
J. L. TILLMAN
521 Colburn Street, Toledo, Ohio

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co.
Tacony, Phila., Pa.

A publication, interesting alike to the engineer and layman, is the new catalogue on Hydraulic Rams, recently issued by the Columbia Engineering Works, of 1000 Johnson St., Portland, Oregon. It is replete with facts and figures which demonstrate the superiority of this device over the old-fashioned ram; a superiority imparted to it by a very ingenious valve mechanism fully described in the catalogue. The most interesting feature of the latter is the disclosure that by virtue of the peculiar construction of the waste valve the shock so pronounced in old style rams is completely subdued, making it possible to increase the size and capacity of single units to mammoth proportions. This feat, formerly considered impracticable, raises the Phillip's Hydraulic Ram to that of a scientific hydraulic engine, which owing to its efficiency, inexpensive operation and comparative simplicity, will fill a long-felt want in hydraulic engineering.

The catalogue contains 54 pages, each of which is covered with interesting reading matter. It can be had for the asking.

A new catalogue has recently been issued by the Booth Water Softening Co., 126 Liberty St., New York, showing some handsome illustrations and a complete detailed description of the three styles of water softening machines built by this concern. A copy will be mailed to any reader, upon request.

The almost daily increasing facilities for handling foreign business are producing changes that would almost make our ancestors jump from their graves in astonishment. That the United States excels in the manufacture of machinery and allied products cannot be denied. The progressive foreign engineer no longer makes the best of the inferior home productions. He sends to America and gets the best; and gives no more thought to the question of distance than the Illinois engineer of 25 years ago did to an order sent to Philadelphia. As an example of the enormity of the export trade, we might state that the Geo. W. Lord Co., of Philadelphia, manufacturers of water purifying chemicals, have, since the first of the year, made the following foreign shipments: One carload, 40,000 pounds, to Montreal, Canada; one carload, 50,000 pounds, to Madras, India; one carload, 30,000 pounds, to Liverpool, England; one carload, 30,000 pounds, to London, England.

Of course, this is a proposition that can be successfully handled over any distance. They do not have to know the general conditions met with in any country. The individual sample of scale tells the whole story. It is carefully analyzed and then they are able to prescribe a compound that will successfully handle the conditions to be dealt with in that particular plant. The process is interesting and is fully described in their booklet, which will be sent free, upon request. Address, Geo. W. Lord Co., 2238-2250 North Ninth St., Philadelphia.

The John S. Bushnell Company, of 126 Liberty Street, New York, has been appointed general sales agent for the United States, outside of New England, by the Stillman-Carmichael Company, of 19 Pearl Street, Boston, Mass., for the Carmichael Damper Regulators. The New England territory will be covered from the home office of the latter Company, at 19 Pearl Street, Boston.

James McCrea & Co., manufacturers of Steam Specialties, Chicago, report that the following jobbers have placed orders for complete stocks of their Emergency Pipe Clamps, since January 1st of this year: Chicago Engineers' Supply Co., McMaster, Davis Supply Co., Henion & Hubbell Co., and Advance Packing and Supply Co., Chicago; Plumbers' and Steam Fitters' Supply Co., Minneapolis; Marshall-Wells Hardware Co., Duluth; Somers, Fitler & Todd Co., Pittsburgh; W. Bingham Co., William Pattison Supply Co., and Strong, Carlisle & Hammond Co., Cleveland; Stuart Machinery Co., and Threshers' Supply Co., Winnipeg, Man.; Bridgman Bros. Co., Philadelphia; Geo. I. Roberts & Bros., and John Simmons Co., New York City; John B. Adt, Baltimore; E. Keeler Co., Williamsport, Pa.; The Muzzy-Lyon Co., Detroit; Erie Mfg. and Supply Co., Erie, Pa.; Syracuse Supply Co., Syracuse, N. Y.; Central Supply Co., and Indiana Supply Co., Indianapolis; Smith-Courtney Co., Richmond, Va.; Columbus Mill and Mine Supply Co., Columbus, O.; Cameron & Barkley Co., Charleston, S. C.; Hartfelder-Garbutt Co., Savanah, Ga.; L. M. Rumsey Mfg. Co., and Western Iron and Supply Co., St. Louis, Mo.; Cotton States Belting and Supply Co., Atlanta, Ga.; Crane-Hawley Co., Cincinnati, O.; Crane Co., Los Angeles; Crane Co., San Francisco; Crane Co., Portland; Crane Co., Seattle; Crane Co., Spokane, Wash.; Crane Co., Salt Lake City; Mine and Smelter Supply Co., Denver and Salt Lake City; Hendrie & Bolthoff Mfg. and Supply Co., Denver.

The New York Public Library, 40 Lafayette Place, New York City, is paying particular attention to collecting current trade catalogues. Their collection now numbers some 30,000 and as fast as possible is being catalogued and shelved in a way to bring out the names of firms issuing each catalogue and the articles listed therein. Every manufacturer, large or small, is requested to send copies of his catalogues, circulars, booklets, or other descriptive literature, and to place the library on the mailing list for copies of all such literature that he may issue in future. The value of such a collection cannot be overrated, and its value increases in direct ratio to the number of pieces from individual manufacturers.

The fourteenth annual edition of Hendricks' Commercial Register of the United States, for Buyers and Sellers, has just been issued. It contains 350,000 names in its 1300 pages and over 14,000 classifications. This book is the most complete work of its kind issued and is especially devoted to the interests of the architectural, civil, mechanical, hydraulic, electrical and sanitary engineering, contracting, electrical, railroad, iron, steel, foundry and machine shop, hardware, mining, mill and factory and kindred industries. It should be very valuable to the buyer or seller, as there is not a material, specialty, apparatus or any kind of machinery used in the industries, under which complete lists of the manufactures of these different things do not appear. The book is now ready for delivery. Price, $7.00. Published by S. E. Hendricks Co., 76 Elm St., New York City.

The American Air Compressor Works, 26 Cortlandt St., New York, U. S. A., have just published a bulletin, sixteen pages, 6 x 9 inches, illustrating and describing a few of their new types of air compressors. Copies of this bulletin will be sent gratis upon application.

Users of high duty vacuum pumps will be interested in the cut shown on page fourteen. These machines are made in many sizes, small as well as large, both steam and power driven.

The cut shown on page ten shows a small belt machine suitable for operating a few air hoists, pneumatic stone tools, etc., or for experimental, laboratory or vacuum purposes, especially where the requirements are small.

The amount of coal burned per horse power is one of the most important things to be considered in a power plant. This has been rendered doubly important during the last few years, since the advent of higher prices for coal. A catalogue recently issued by the Wetzel Mechanical Stoker Co., of Trenton, N. J., brings out these facts clearly, together with the essential characteristics of a satisfactory mechanical stoker. This firm manufactures the Wetzel Mechanical Stoker, which has been used successfully on many types of boilers. Many interesting applications are shown in their catalogue, which will be sent to any reader of "The Practical Engineer."

A metallic packing which cannot cut and always holds on all kinds of piston rods and valve rods, is made by the Law Metallic Packing Co., 44 Court St., Brooklyn, N. Y. Send for a catalogue showing its construction and various applications.

A new catalogue has just been issued by the Consolidated Engine-Stop Company, 100 Broadway, New York. It describes in detail the mechanical features of the Monarch Engine-Stop and Speed Limit System, which prevents racing engines and resulting fly-wheel accidents. It is applicable to all kinds of condensing and non-condensing engines. Since an ounce of prevention is worth a pound of cure, any device which will prevent an engine from running away is a device of exceptional engineering interest. This description will be sent to any reader of "The Practical Engineer" who is interested.

Grapho is a compound of selected materials and the finest quality of graphite, compounded in such proportions that the graphite will mix thoroughly and evenly with lubricating oils and remain in suspension. A sample cake of grapho will be mailed free to any engineer who desires to give it a trial. Address, Grapho Mfg. Co., Cor. Frank and Commercial Sts., Rochester, N. Y.